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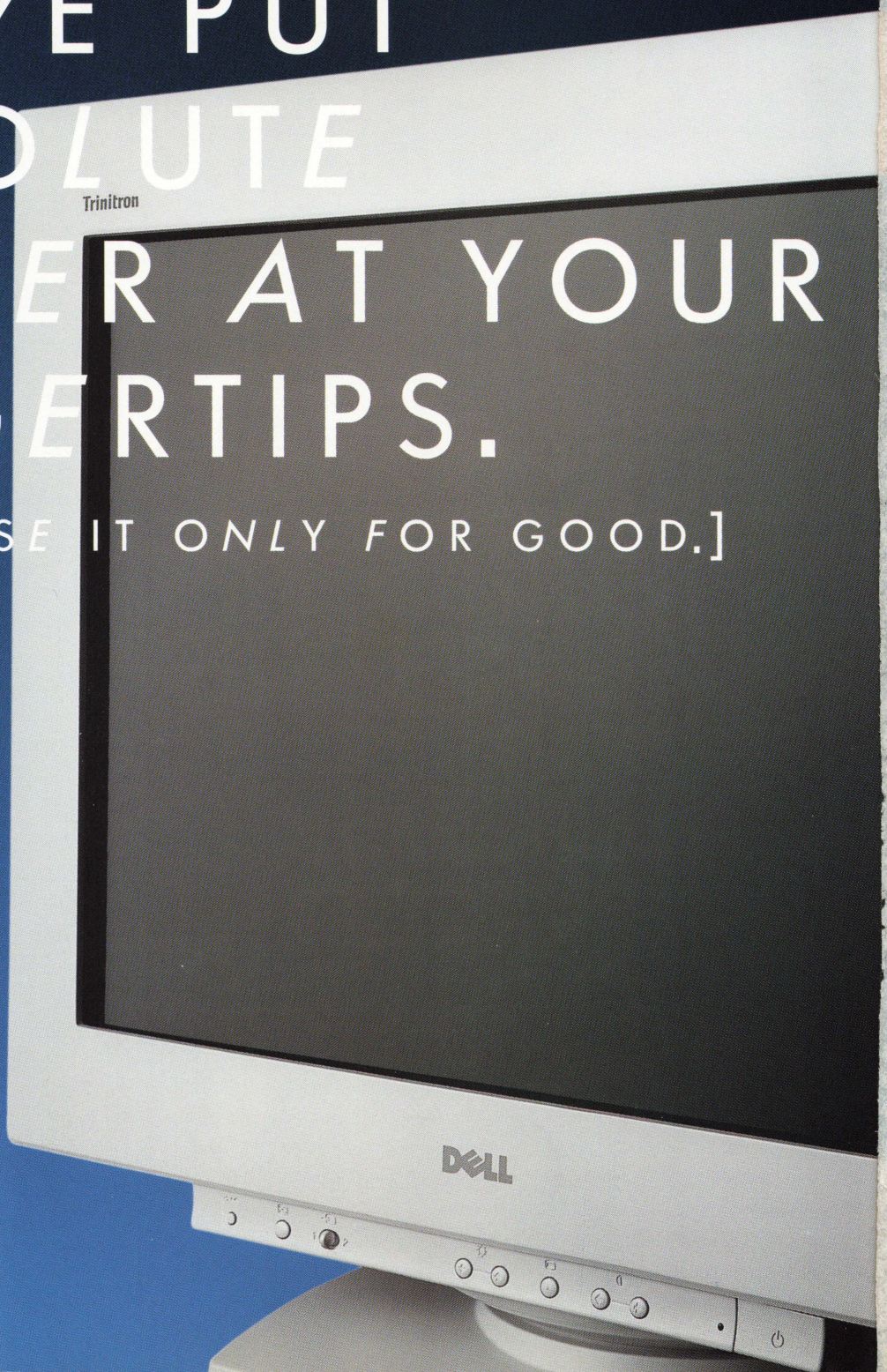

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INNOVATION IN VISUAL COMPUTING
Volume 22, Number 12
December 1999

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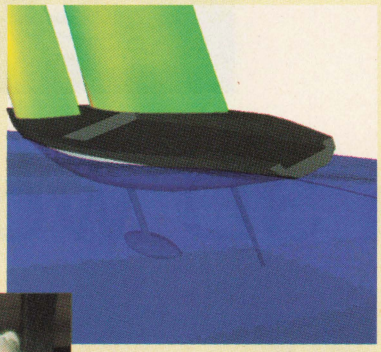

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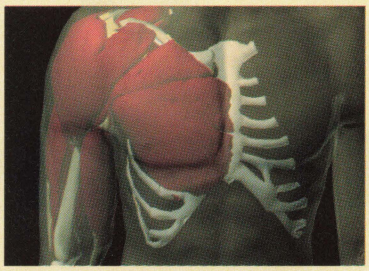

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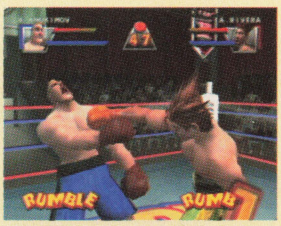

**ON THE COVER**

The AmericaOne team used AutoCAD 2000 to create its America's Cup yachts. To create our cover, Yann Bertaud, a quality engineer at Discreet, exported a CAD model of the *AmericaOne* to 3D Studio Max R3, then added textures and shadows created in Adobe Systems' Photoshop 5 and Illustrator 8 for the water and sails. For more about how AmericaOne, Team New Zealand, and Team Prada used computer graphics to design the fastest fleets in history, see page 24.

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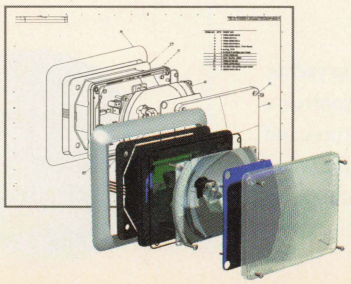

**For over 30 years, Weldon Technologies has been providing lighting and control systems for specialty vehicles like ambulances, school buses and fire trucks. Faced with increasing competition and industry consolidation, they needed a way to streamline their design process. They chose SolidWorks solid modeling software. "It's a**

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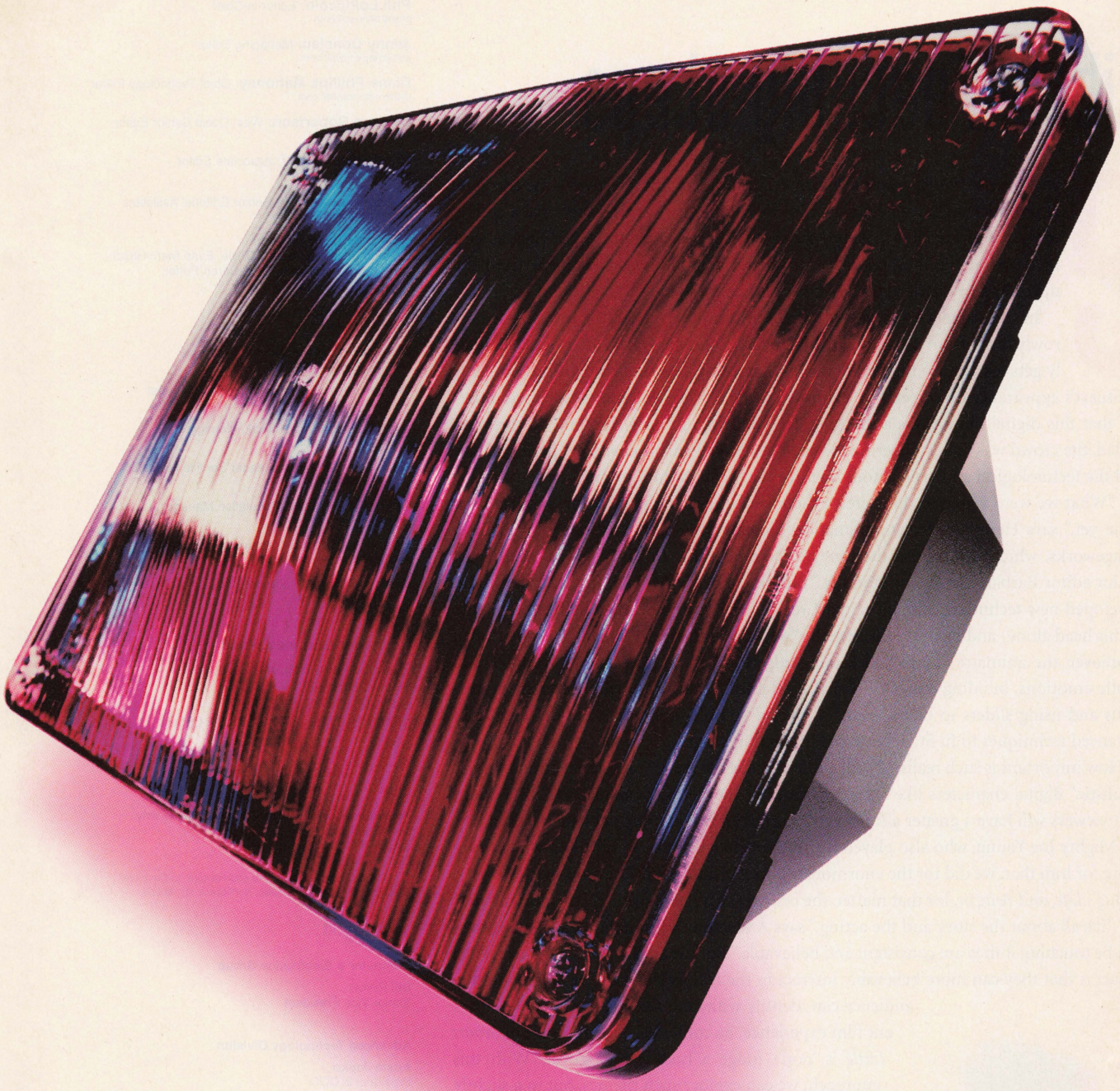

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**very tightly integrated package for complex modeling," said Sean Tillinghast, Weldon Vice President of Engineering, after being disappointed with several other software solutions. "With SolidWorks, we were able to create the first combination halogen/strobe lamp for the EMS market while reducing our design cycle 25%."**

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# Little Feet, Big Steps

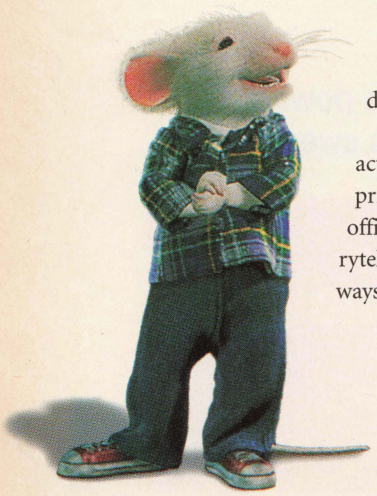
Every year at the Siggraph Electronic Theater animation festival—the computer graphics industry's equivalent of the Academy Awards—there are a couple of short films or clips that steal the show. This year, one of the favorites, at least in terms of the most animated audience reaction, was a segment from the upcoming live-action movie *Stuart Little.*

In the sequence, Stuart—a cute little computer-generated mouse—is narrowly saved from drowning by his "mother" (Geena Davis) after he accidentally gets tossed into the family washing machine. I'm sure that within moments of Stuart's appearance on screen, the majority of viewers had willingly suspended disbelief that this digital mouse was a thinking, feeling being. And by the time the segment ended, the crowd was loudly cheering the character's realism, his charming performance, and the technological and artistic tour de force that brought him to the screen.

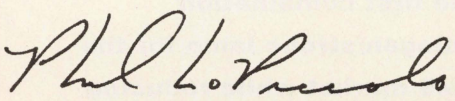
"What we were trying to do is create the most believable digital actor that has been done yet," says Henry Anderson, animation director for *Stuart Little* at Sony Pictures Imageworks, which will release the film on December 10. To that end, as West Coast senior editor Barbara Robertson notes in "Building a Better Mouse" (pg. 32), the studio developed new technologies to give Stuart realistic fur (using nearly a half million hairs on his head alone) and clothing (by actually "weaving" individual threads into the cloth). Moreover, the animators employed leading-edge tools to convey Stuart's complex and subtle emotions, building scores of digital models of Stuart's face with different expressions and using sliders to blend them in myriad combinations. In addition, they used advanced techniques to fit Stuart into the live-action scenes.

How important is such realism? Will audiences feel a stronger emotional bond to more "realistic" digital characters like Stuart than to his 3D predecessors? There's little doubt that viewers will have a greater affinity for Stuart, with his winning personality, than, say, for Mighty Joe Young, who also played the title role in a live-action film. But will we care more for him than we did for the enormously popular stars of all-CG films like *Toy Story, A Bug's Life,* and *Antz* or, for that matter, the beloved characters from 2D cartoon movies?

"It's all about the story and the acting," says Anderson. "Even hand-drawn characters can be touching if they are consistent and believable." But the advantage of characters like Stuart is that they can more believably interact in the real world with live actors that the audience can identify with, and that creates a whole different film experience, he contends. "The message in *Stuart Little* is 'don't judge a book by its cover.' With this approach, we can explore such themes, but in a slightly different way than by using only human actors."



Will Stuart be perceived as the most believable digital actor ever created for a full-length film? I wouldn't be surprised. If audiences accept Stuart, and the movie is a box-office hit, it will open the door wider for novel forms of storytelling using virtual characters and give filmmakers new ways to help us see and understand ourselves.



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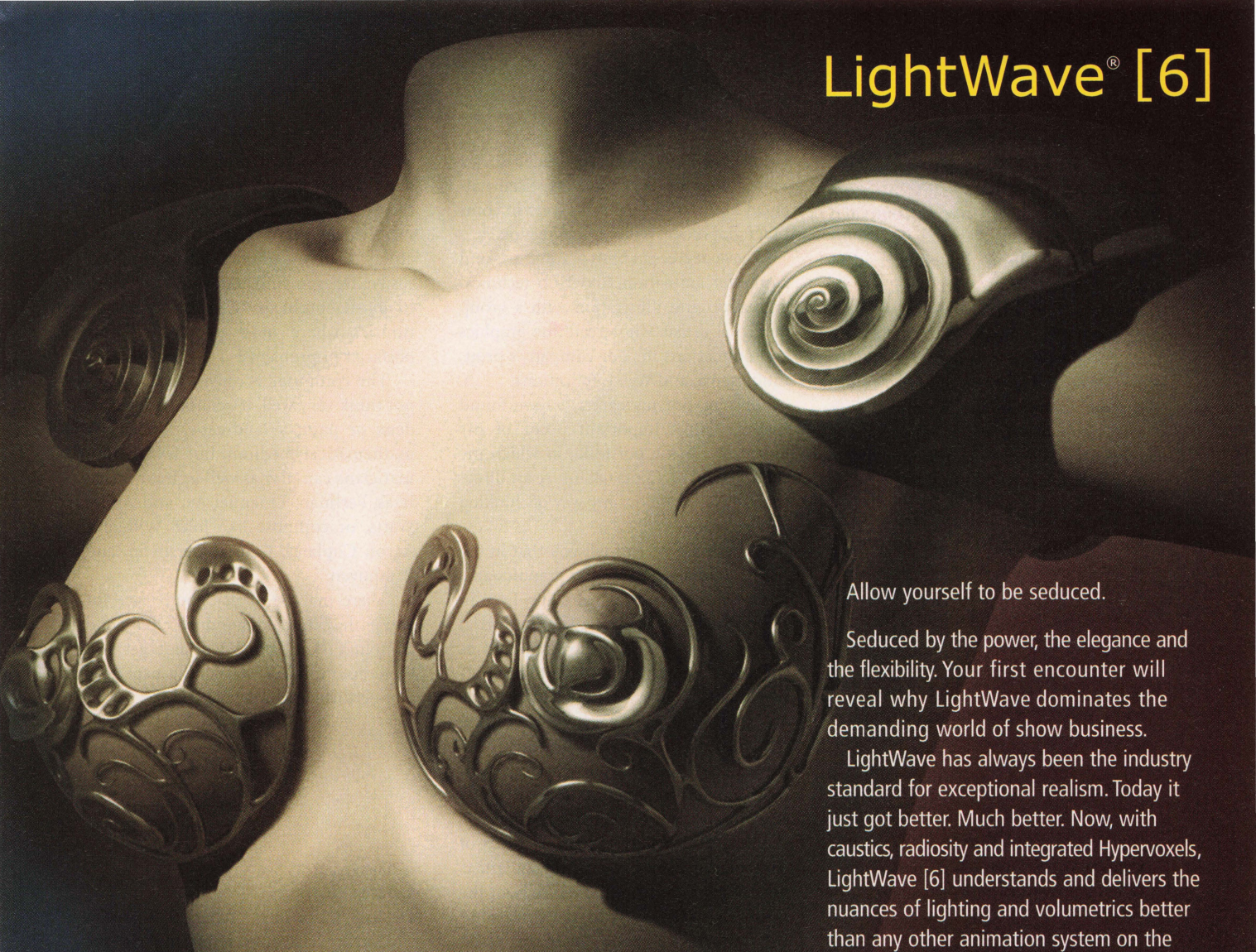

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## License to Practice Computer Graphics

*In the September 1999 issue of* Computer Graphics World, *we published a letter from Doron Galili of Chicago, Illinois, that asked readers to weigh in on the necessities and advantages of an artistic background for a computer graphics professional. Doron's letter, and our reply to it, generated a number of responses, one of which appeared in the Viewpoint column of the November issue ("The Science of Art," pg. 24). A portion of Doron's original letter, our response, and a sampling of subsequent replies, follow:*

> I'm attending the University of Illinois this fall, and I'm interested in pursuing a career in computer graphics in the film industry. I am fairly good at math, and I like to think I'm a proficient computer user. A possible problem, however, is that I am not as artistically talented as some other people I know. Will this greatly hinder me in my chosen career?

### Our Reply

*You don't have to be artistically talented yourself—you just need to understand what kinds of tools artists need, and then know how to create these tools.*

### Artistic Skills a Must

I send this letter in response to *Computer Graphics World's* reply to Doron Galili, in which you stated that a person does not need to be artistically talented in order to pursue a career in computer graphics for film. I disagree totally.

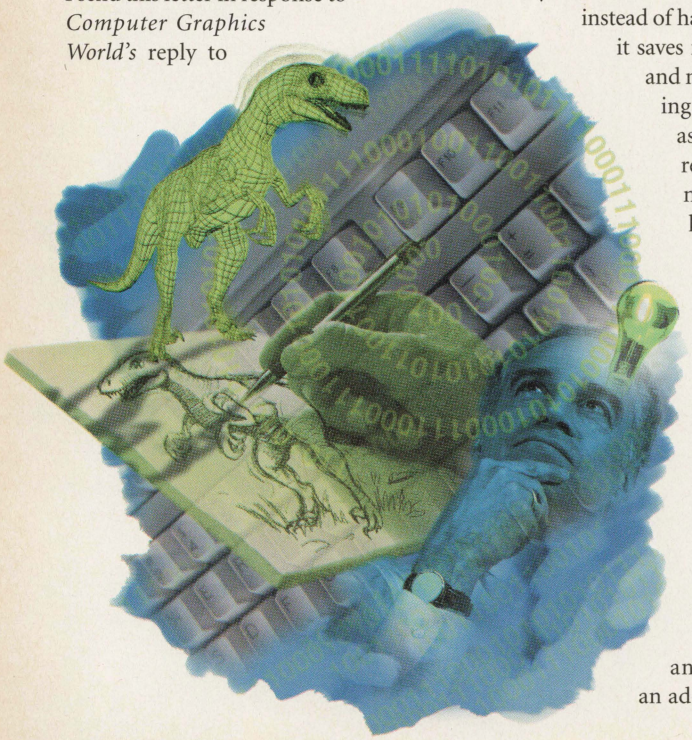
I have degrees in both graphic arts and computer animation, and I do technical animation and illustration with a group of digital artists who create the graphics and animations for our company's print, multimedia, and Web publications.

Throughout my career, I have found that the most important proof of my knowledge is my portfolio, in which my sketches and concepts tell future art directors everything about my way of thinking and my artistic skills.

Believe me when I tell you that in the movie industry, a computer graphics/animation artist needs artistic skills. Even in my current job as a technical/industrial animator, drawing skills are required as well as an analytical approach to presenting visually intensive material. I have to be able to draw and present my ideas during the pre-production phase. Luckily, I gained these skills while working for a local movie production company, doing storyboards and conceptual drawings.

But I also believe that in all fields of computer graphics, we as digital artists must learn as much as possible about the operating system and programs related to the platform we use to create our work. Time is money, and if I can troubleshoot my machine whenever there is a problem instead of having to call for support, it saves my employer both time and money. Any skills involving troubleshooting as well as hardware upgrades or repairs only make you more marketable. Just hang out at the computer labs talking to the techs. You'll be surprised at what you learn.

Freddie Torres
*Houston, TX*



### Get the Big Picture

I am an art director at a university. I have also worked in a design studio, and have been a partner and creative director in an ad agency.

My answer to Doron Galili is that I don't think "artists" will be entirely concerned about your "artistic talent" but they will be very interested in your creativity! Can you think "out of the box" easily? Do you find innovative solutions to unusual problems? Can you see opportunities where most people see only obstacles or problems?

The computer is only a tool. It cannot think very well. It cannot do a pas de deux or paint a landscape. Music is a mathematical medium, but few mathematicians can play as well as Isaac Stern, Itzak Perlman, Emanuel Ax, and Andre Watts, or compose like John Williams, Aaron Copland, George Gershwin, and Beethoven.

There may be a very good place for you in the filmmaking industry, but good computer skills alone will not get you there. Your total talent, training, expertise, and performance are what count.

Jim Raatz
*Art Director*
*Engineering Program Office*
*Texas A&M University*
*College Station, TX*

## Corrections

On page 62 of the October 1999 issue, a statement regarding rendering on the *ConocoLand* project should have read: "Texturing was performed in Adobe Systems' (San Jose) Photoshop...."

On page 64 of the same issue, in "A Picture's Worth a Thousand Lines," a reference to the product Paint Shop Pro in the fifth paragraph should have read: "Using PhotoModeler Pro, Hess pulled off textures from the photos and placed them on the model."

## We Value Your Input

We welcome any insights you may have that would further our readers' understanding of topics discussed in this issue. We may edit your response to conform to our style and space requirements.
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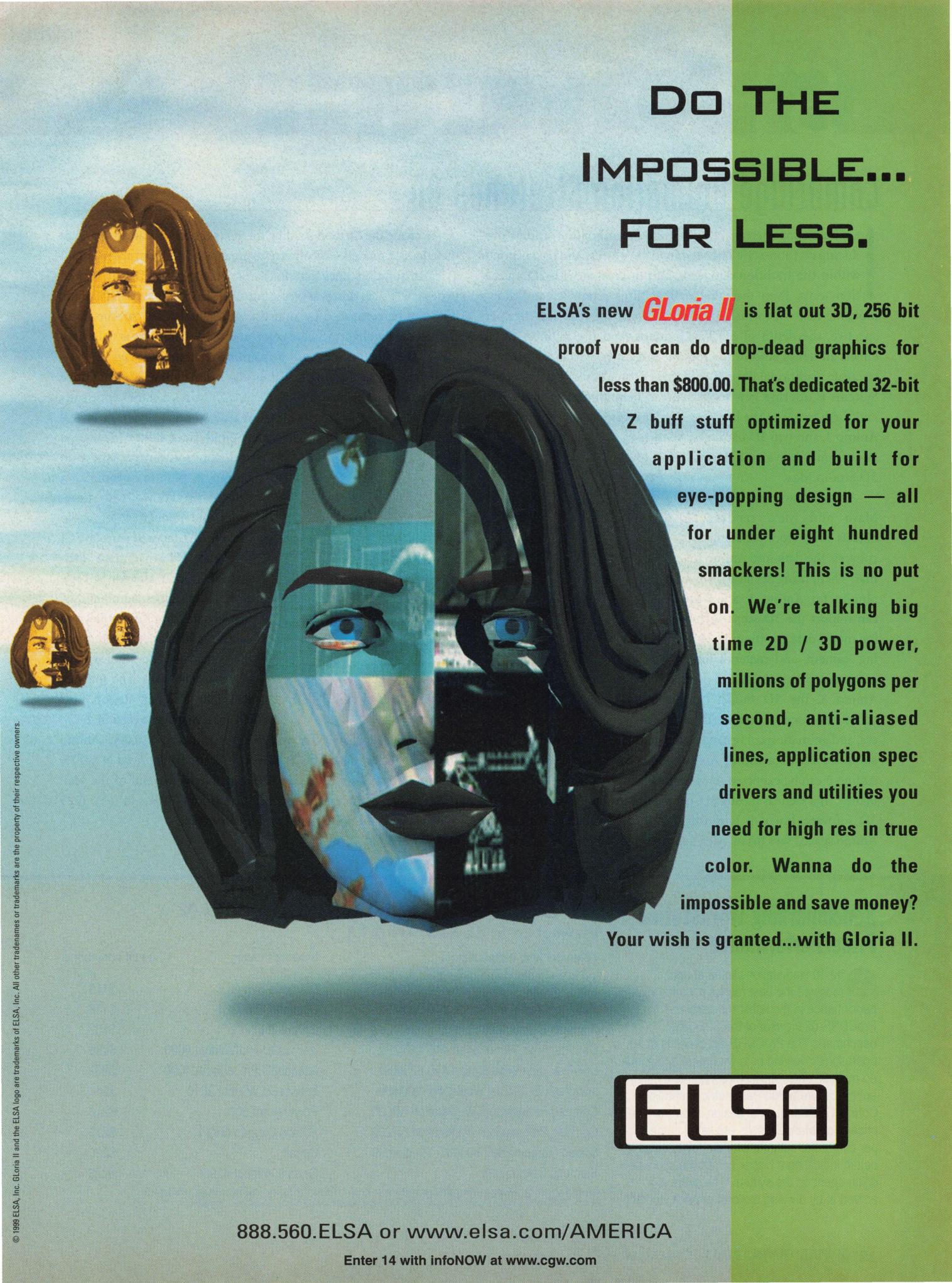
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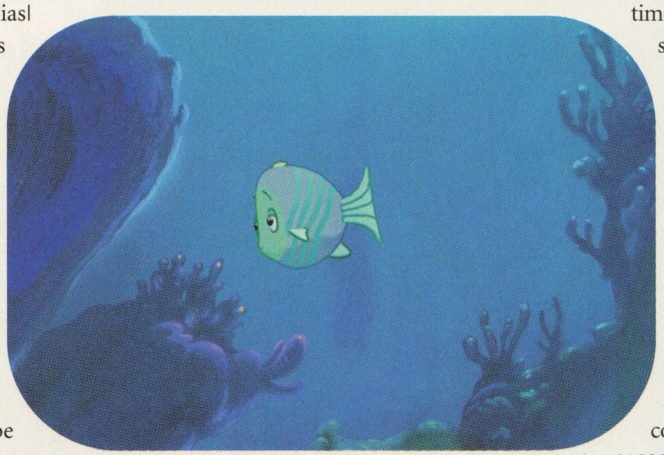
# SPOTLIGHT

## Cambridge Animation Stretches 2D

It is becoming increasingly common for animation studios producing cartoon-style films to blend 3D objects and backgrounds within the traditional-looking output created with 2D animation tools. Even though the final films retain a hand-drawn look, the ease with which 3D objects can be rotated to change perspective, the depth of 3D backgrounds, and the richness of 3D effects all tempt studios to cross the line and begin using 3D tools to create traditional films. To aid this effort, Cambridge Animation Systems is offering new tools that can help animators move back and forth between the latest version of its 2D animation software, Animo 3, and two 3D packages, Alias|Wavefront's Maya and Discreet's 3D Studio Max.



Animo Inkworks, a plug-in for Maya and Max, renders 3D objects with 'toon shading and converts the data into Animo format. Then, using Scene III, a new plug-in for Animo 3, animators can import the 3D scene including model data, positioning, lighting, camera, and material information into Animo 3. Once inside Animo 3, the 3D model can be scaled and rotated, and the lights, camera, and animation curve can be adjusted. The 3D data can be viewed alongside 2D data within Animo 3 and scenes composited within Animo 3 can be exported to Maya or Max for viewing as 2D texture planes. "If a scene is mostly 3D, people will probably work within the 3D software, but if it is mostly 2D, they'll probably work in the Animo space," says Brian Tyler, vice president of sales and marketing.

To create the cartoon shading for 3D geometry, Inkworks handles the edges of models as geometry to create the ink lines, according to Tyler. In addition, lines that don't exist on the model can be created to designate such things as crease lines. The thickness and shape of the lines can be controlled by an artist who can also set parameters to change the highlighting, base color, and shade color of the materials. "We're keeping the lines and the painting separate," says Tyler.

In addition to these tools, Cambridge Animation will roll out three other packages this year. Pencil Tester (£750 UK), a stand-alone software package for NT machines, can play scanned drawings in real time. Sound Track Editor ($2,000), a stand-alone software package or an Animo 3 plug-in, produces a printed breakdown with timecodes and phonemes for audio files on DAT tapes. It runs on SGI Irix and NT machines. Production Tracker, also for SGI Irix and NT machines, automatically logs in data from Animo files and can use information entered into the system to help studios track job status and costs. The software costs £500 UK per station plus £1000UK for a manager's version.

Animo 3, for SGI Irix and NT machines, is $10,000. Animo Inkworks for Maya or Max is £750 UK. Scene III is priced at $4125. All the software is scheduled to be available by the end of the year. (Cambridge Animation Systems; Cambridge, UK; 44 (0) 1223 578100; www.animo.com)—*Barbara Robertson*

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News

## Benchmarking Workstation Price/Performance

The 10 workstations listed at right received the best ratings for price vs. performance in the latest results of the ProCDRS-02 viewset of the SPEC/GPC benchmark. The ProCDRS set consists of 10 operations involving both wireframe and shaded models, each of which represents a different procedure within Parametric Technology Corp.'s CDRS industrial design software. The price/performance results are listed in the $ per composite column, where a lower value is better, indicating a higher composite score per dollar spent on the system. The score is arrived at by dividing the cost of each workstation by the composite score.

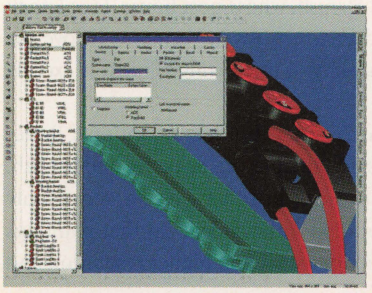
### Best Price/Performance Results for the ProCDRS-02 Viewset of SPECviewperf 6.1.1

| COMPANY AND WORKSTATION | GRAPHICS CARD | $ PER COMPOSITE |
|---|---|---|
| Dell Precision WorkStation 410 450MHz | Diamond Fire GL1 | $118 |
| Dell Precision WorkStation 410 600MHz | Diamond Fire GL1 | $126 |
| Siemens Celsius 620 | Celsius GL | $157 |
| Dell Precision WorkStation 410 450MHz | Intense3D Pro Wildcat 4000 | $186 |
| Dell Precision WorkStation 410 600MHz | Intense3D Pro Wildcat 4000 | $207 |
| Intergraph Zx1 ViZual Workstation 600MHz | Intense3D Wildcat 3510 | $217 |
| Compaq Professional Workstation AP500 | Powerstorm 600 | $218 |
| Compaq Professional Workstation AP200 | 3Dlabs Oxygen GVX1 | $219 |
| Silicon Graphics 320 600MHz Pentium III | Cobalt | $220 |
| Siemens Celsius 620 | Celsius Wildcat 4105 | $223 |

Lowest $ amount per composite represents best performance for overall price. Companies listed are voluntary participants.
Source: SPEC/GPC benchmark results October 1999. Copyright Standard Performance Evaluation Corporation.

## An Ironclad New IronCAD

The latest version of Visionary Design Systems' IronCAD solid-modeling package should bring users one step closer to achieving the ever-illusive goal of CAD system interoperability. IronCAD 3.0 is built around what the manufacturer calls a Unified Modeling Engine, which simultaneously incorporates the ACIS and Parasolid solid-modeling kernels to facilitate the import and export of most native CAD, CAE, and CAM files (support for additional kernels is in the works). Such a capability eliminates the data-translation problems often encountered using standard translation file formats.



With the multi-kernel technology, any part in any assembly can be set to use either the ACIS or Parasolid kernel. Parts can be changed to use the alternate kernel at any time. If one kernel fails during a modeling operation, the software switches to the other kernel.

Also new in IronCAD 3.0 is constraint-free part and assembly substitution, which allows engineers to leverage previous designs in the creation of new ones. The software also integrates Microsoft Visual Basic for Applications (VBA). Thus, engineers can customize IronCAD for vertical applications using VBA Macros.

Parametric relationships have also been extended to encompass 2D and 3D SmartDimensions and IntelliShape variables across parts and assemblies. And a new Parameter Table lets users view and edit the parameters and relationships of a feature, part, or assembly. Relationships across assembly levels update automatically when assembly structures change.

Other advances include enhanced intelligent 2D drawing functions, file-size reductions, decreased load times, and improved handle behavior.

Priced at $4995, IronCAD 3.0 is available for Windows 95/98/NT. (Visionary Design Systems; Santa Clara, CA; 408-969-8000; www/ironcad .com) *—Diana Phillips Mahoney*

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## Pixologic Merges 2D with 3D

A new product from a new company, ZBrush from Pixologic has been designed to close the gap between 2D and 3D sculpting and painting, with an emphasis on ease of use. Artists employ tools and palettes in a manner analogous to 2D painting applications, but ZBrush's proprietary technology embeds depth and material information in each pixel of an image, giving users the ability to create 3D content without calculations, wireframes, or NURBs. Using a brush or other tool, users create and distort objects with intuitive pushing and pulling motions, then paint textures and other attributes directly onto the objects.

Among the product's strongest attributes are its graphically appealing and accessible menu bars, which run along both sides of the screen. The menus are highly configurable, so users can keep the tools and palettes they use most often at close range.

Graphics artist Peter Kim, who develops videogames for Electronic Arts, is an early user of ZBrush. "The materials editor, which lets you paint textures on objects with a brush, is really intuitive, and a time-saver." He says that before using ZBrush, he used Photoshop to apply textures to objects, "which works well but is labor-intensive." Other 3D paint programs he has used require fewer steps, but are not as precise as Photoshop. The alternative, ZBrush, "could be the texture-painting product for the videogame industry."

ZBrush was scheduled to ship in Q4 of 1999 at an introductory price of $300. A demo version is available on the company's Web site. Pixologic recommends a Pentium III and 128MB of RAM to run ZBrush. The company plans to release a Mac version in 2000. (Pixologic; Los Angeles; 888-748-5967; www.pixologic.com) *—Jenny Donelan*

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tion by its mean performance results.

To see how the same workstations fared in different benchmark tests and to view results from additional workstations, visit SPEC/GPC's Web site at www.spec.org/gpc.

## In Brief

**Crater Software**, a European-based developer of 2D cel animation software for film and television, has opened North American offices in Montreal....3D immersive display manufacturer **n-vision** (McLean, VA) announced that it has agreed to merge with a subsidiary of **Advanced Technology Systems**, an engineering software developer also based in McLean....**SDRC** (Cincinnati, OH) has acquired product development software developer **TD Technologies** (Richardson, TX). The acquisition is SDRC's second in the third quarter of 1999 (It has also acquired **Enterprise Software Products**)....**The Visual Effects Society**, the world's largest organization of visual effects professionals, has relocated its administrative offices to Santa Monica, California.... **OnCourse Technologies** (New Berlin, WI) has acquired **Cimtronics** (Scottsdale, AZ), a sales and marketing organization that represents manufacturing software developers. OnCourse acquired CAD/CAM distributor **CAM Solutions** earlier this year.

# Synthetik Debuts 'Intelligent' Paint Program

Studio Artist is a painting and drawing program for the Macintosh that is, according to its developer, Synthetik Software, "the world's first graphics synthesizer." Just as music synthesizers allow the creation of custom sounds through nearly limitless combinations, so does Studio Artist permit users to create their own paints, using over 200 editable parameters. The results can be combined with the program's image-processing and video-effects suite to provide richly colored static images or QuickTime motion sequences.

For users who desire fewer choices, Studio Artist offers 600 factory preset paints (though these too can be customized). And because the program contains proprietary code that, according to Synthetik, is modeled on the human visual system, Studio Artist can paint on its own. If, for example, you'd like to create an impressionist-style image based on a photograph of a flower (or other QuickTime-compatible files), Studio Artist will, with the setting of a few parameters and the the click of a menu button, proceed to actually paint (rather than simply apply a filter to) its own impressionist interpretation of the flower. This capability is exciting, or frightening, depending on your point of view. But Studio Artist's "intelligent-assisted" painting and drawing capability can also be harnessed to perform repetitive drawing tasks, or to create images on an interactive basis, with the user controlling the automated process on a step-by-step basis.

"Working with Studio Artist is a lot like improvising on a musical instrument," says Michael Hanish, whose post house, Free Lunch Media Production, is located in Green River, Vermont. "I love the [brush]stroking and the possibility of interacting while it is executing its algorithms."

Studio Artist paints in raster mode, but has an optional Bezier Recording feature that will save editable vector paths underneath. Users also have the option to work in raster-only or vector-only modes. The program is resolution independent, so that paintings created at low-res can be re-rendered later at higher resolution and with added detail.

Other Studio Artist features include the ability to autopaint or autorotoscope a QuickTime video, frame by frame. The user sets up a series of paint and image-processing operations, then lets Studio Artist automatically generate a "hand-painted" video sequence. The program also allows keyframe image warps, morphs, and video feedback effects, as well as real-time warping and kaleidoscope effects.

The product requires a PowerPC-based Macintosh, OS 8, and at least 32MB to run. A PC-based version is due out next year. The program costs $295, but a limited-capability demo version is available from the company's Web site. (Synthetik Software; San Francisco, CA; 415-864-6582; www.synthetik.com) —*JD*

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# C4W Brings CAD to the Masses

Windows users can not only view, but also alter, measure, and analyze CAD models with 3D Shop VR from C4W.COM. The new program is designed to extend model access beyond the traditional CAD operators in an enterprise to staff members in areas such as purchasing or quality assurance. In order to make the models more accessible to a wide range of office personnel, 3D Shop VR uses an interface similar to that of Microsoft Office, and integrates smoothly with that suite of tools.

3D Shop VR can read IGES, DXF, and VRML files, and can convert outgoing files to these formats. The program is not intended as a real-time collaboration tool—it includes no file compression, version control, or transfer mechanisms. But it does provide a great deal of CAD power to the desktop PC user who formerly had to mark up changes on a printout.

3D Shop VR is available for $499. It requires a machine running Windows 95/98/NT. 3D Shop X-Pert, which allows the creation of engineering models and applications for the Windows platform, will ship in Q4 of 1999, for a price of $1999. (C4W.COM; Hollis, NH; 888-463-7747; www.c4w.com)—*JD*

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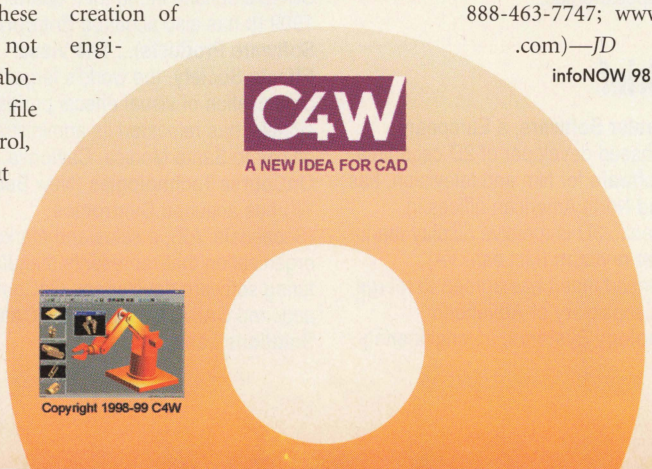

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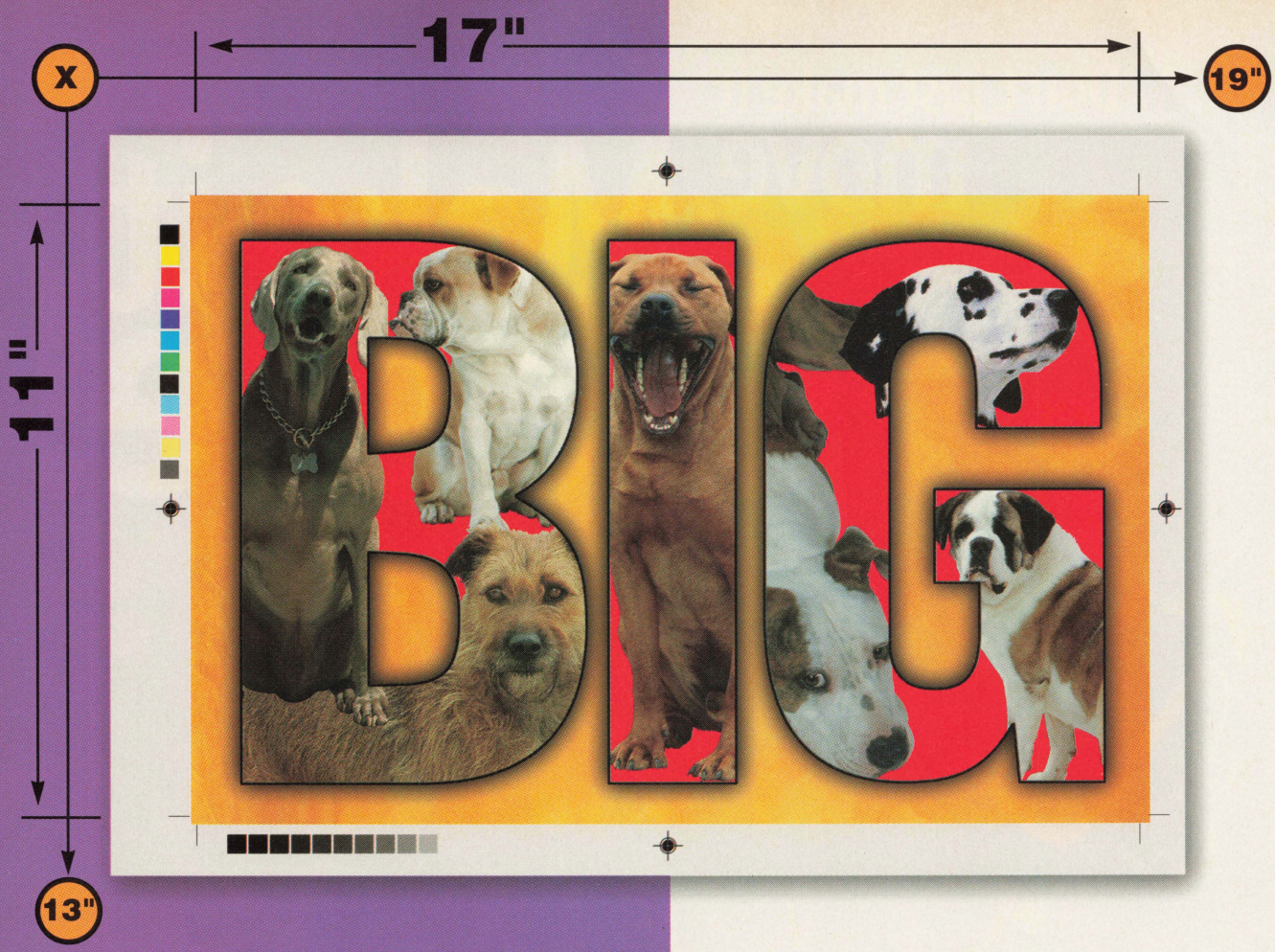


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# A Big Picture Show

## A distributed graphics system eases the development of applications for large-scale displays

DIANA PHILLIPS MAHONEY

Large-scale, high-resolution displays are the latest rage in computer graphics, promising to change the way people and groups work with computer images and each other. Interactive walls and immersive rooms offer new approaches to data visualization and collaboration and provide a higher-resolution medium for exploring many levels of detail. Preparing visual data for these environments, however, invites new challenges related to the size, resolution, brightness, contrast, and orientation of the display. Additionally, because traditional user-interface metaphors such as the window/keyboard/mouse standard are ill-suited to large-scale displays, they must be replaced with more intuitive tools geared specifically to the environments.

Such is the goal of researchers in the Computer Science Department at Stanford University who have developed a "virtual" graphics system to meet the unique needs of large displays. The scalable system, which supports multiple, simultaneous rendering streams from local and remote sites, makes the number of computers, graphics subsystems, and projectors used to create the display environment irrelevant to the application developer. It also uses a unique transparent layering system rather than windows to manage the screen.

The display project actually came about as a way to support another research group at Stanford focusing on human-computer interaction, including the design of appropriate interaction techniques for large, high-resolution displays. To facilitate this investigation, Greg Humphreys and his colleagues in the Computer Science Department designed a tiled, back-projected display called the "Interactive Mural," which uses an overlapping array of eight projectors connected to a high-performance graphics system that back-project onto a diffuse screen to form a 6-by-2-foot display area. Each projector has a resolution of 1024-by-768.

The researchers developed the virtual graphics system to drive the display. Through the system, a single large display is created by overlapping multiple projectors and feathering along the seams of the resulting projection areas. The system, which may be partitioned across multiple machines, "virtualizes" the distributed graphics resources, including variable numbers of computers, graphics cards, and video output ports. This is important, says Humphreys, because it enables applications to run without modification regardless of the actual physical configuration of the devices. "Right now, we have eight PCs, each with a projector connected to it. They're entirely separate. Yet the display, to the application programmer, appears

**By using transparent layers rather than conventional windows, Stanford's distributed graphics system provides developers with greater flexibility in designing intuitive interfaces for large-scale display media. An example, below, is the use of overlay option boxes that appear on the display without obscuring the underlying data.**

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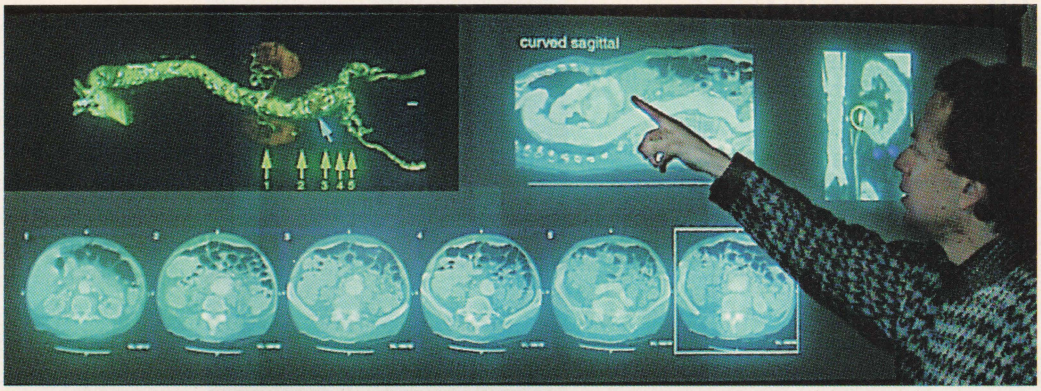



**Researchers at remote sites can share complex data, such as these scientific visualizations, without concern for the underlying display configuration. The virtual graphics system supports multiple, simultaneous rendering streams from local and remote sites.**

as one logical device." This means that a programmer writing code for this system does not need to consider the display configuration to program an application. "The programmer doesn't have to know whether the display is running on a network of workstations or on a supercomputer or on three supercomputers. He or she just knows the display is this many pixels wide by this many pixels tall."

The programmer also doesn't need to worry about the area on the display where the projector output overlaps. This can be a nagging problem with traditional projection-based display systems, because the overlap areas are twice as bright as the normal projection area. "Some commercial vendors have solved this problem by creating special hardware that makes the [projection] signal dimmer near the edge. With our graphics system, we don't need custom hardware. We're able to achieve the same result in software, and the programmer doesn't have to do anything," says Humphreys.

A particularly significant characteristic of the virtual graphics system is its reliance on transparent layers rather than conventional windows for the display interface. The layers behave like windows in that they are rectangular areas stacked back to front, which the application developer manages and draws into. Unlike opaque windows, which obscure the contents of underlying windows, the layers are completely transparent, except areas that are drawn on, which are partially transparent. "This provides a lot of flexibility," says Humphreys. " I could have two applications running at the same time, each of which has one layer. You can actually have the two applications render graphics and have the results blended together to form one final image, which is difficult to do in today's graphics systems." This capability enables such effects as overlay menus, whereby a popup menu appears over the data being manipulated. "Because it is partially transparent, it wouldn't obscure the data being visualized. But it would give the user a way to make choices without a fixed interface, like menus dropping down from the top, which might not be appropriate for the kind of interaction the application calls for.

> The system 'virtualizes' the underlying resources, so that the elements making up the display appear as one logical device to the application programmer.

Among the applications Humphreys sees this display system being most useful for is the visualization of complex datasets. "Often, with the large datasets people want to look at, there's a macro/micro thing going on. They might want to step back and get an overview of the big picture, then physically walk closer to see the detail. They need the high resolution and display real estate to be able to do this," he says.

An additional objective of the system, says Humphreys, is the ability to provide such flexibility in support of multiple remote applications. "We went to great pains to make sure applications could be run over networks to support activities like remote collaboration, where you display a dataset remotely on a large display like this and multiple people interact with the data simultaneously."

To further investigate the collaborative potential of the display technology, Humphreys is currently working with researchers in Stanford's Civil Engineering department. "We're looking at combining display technologies to help construction engineers and contractors plan and manage large-scale building projects."

To this end, the group has built a room full of various types of displays, including a tabletop display and tiled front and side displays. "You could imagine having a 3D model of a building on the table, some sort of timeline on the front display, and charts and CAD drawings on the side wall, then giving the various people involved in the project tools to manipulate these things. When they make changes to one piece of data, everything else would change in concert." Some implementation of the distributed graphics system would be well suited to such an environment, says Humphreys, "so we're now looking at providing software for application developers to write effective programs for environments that have multiple displays and multiple input devices."

The biggest obstacle Humphreys and his team must overcome in further developing the display technology is the breakdown of traditional interaction metaphors when moving data from a workstation monitor to the large-scale media. "We know that the keyboard and mouse are not what we want. Our challenge is to figure out how to interact with these things and how to write software that lets application programmers take advantage of different interaction methods. Determining the right interaction metaphor is the only way we're going to be able to get compelling applications running on displays like this."

*Diana Phillips Mahoney is chief technology editor of* Computer Graphics World.

# Bigger, Better Ultrasound Volumes

A technique for mosaicing 3D ultrasound images provides a novel tool for medical simulations

There's no question that computer visualization has revolutionized the field of medical imaging. The ability to generate 3D volumetric models of human anatomy based on data acquired through one of a number of imaging technologies provides physicians with an invaluable perspective on their patients' inner workings.

These visualizations, which are used for such purposes as treatment planning and physician education, typically rely on reconstructions of sequential 2D image "slices" of patient anatomy acquired either through computed tomography (CT) or magnetic resonance imaging (MRI). These imaging techniques have long been favored because they produce relatively distinct, clean pictures, which eases the digital reconstruction of the 3D volume.

For years, imaging specialists have been seeking ways to obtain similar results from other imaging methods, particularly ultrasound, which is an inexpensive, more readily available, and risk-free imaging method. Unfortunately, despite its benefits, ultrasound data is rarely used as the basis for creating digital 3D models, primarily because it produces noisy, fuzzy pictures.

The system exploits ultrasound's benefits while alleviating the technology's hallmark noise and deformations.

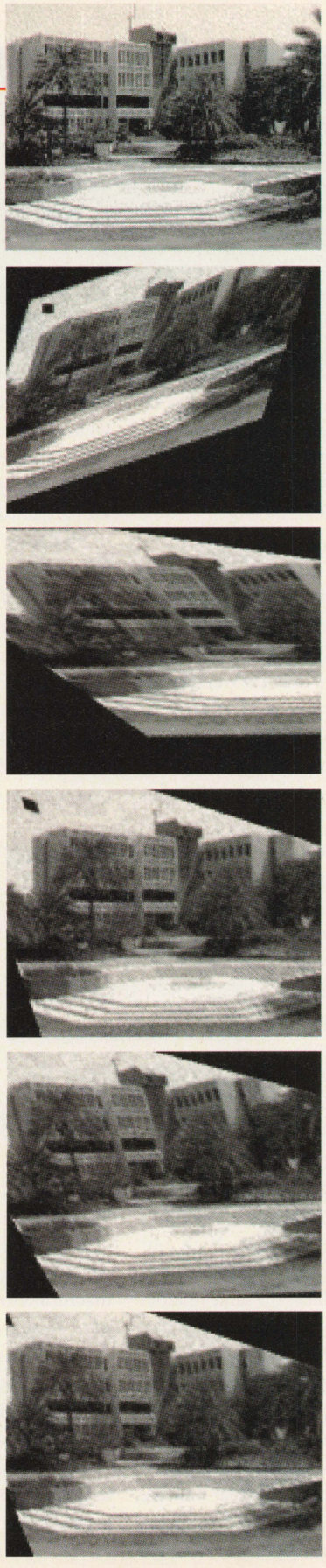
With an eye toward leveling the playing field among imaging technologies in this arena, visualization experts at an Israeli medical simulation company called MedSim Ltd., in conjunction with researchers at the University of Tel-Aviv, have developed a 3D visualization system meant to exploit the benefits of ultrasound imaging while alleviating the hallmark noise and deformations associated with the technology.

The method automatically aligns and registers pairs of ultrasound scans acquired from slightly different perspectives, but which have a significant overlap, then transforms them using a technique akin to morphing in order to create a single volume that smoothly combines the information from both. Groups of these transformed volumes are then stitched together in a mosaic in order to represent a large scanned area. "It's impossible to image large portions of the body with a single ultrasound scan because of the limitations of conventional ultrasound devices. The best one can do is to scan small volumes one at a time and combine them into a larger one," says project collaborator Daniel Cohen-Or, a computer science professor at the University of Tel-Aviv.

With CT and MRI data, such alignment and registration is often achieved using a feature-based registration method, whereby distinctive features (such as boundaries and edges) of scanned images are identified either automatically or manually and aligned using some sort of data interpolation or warping technique.

Such an approach is ill-suited to ultrasound data, however, because 3D features in an ultrasound can appear significantly different in two acquired images, even if the perspectives from which they were acquired are very close. Such variations can be attributed to many sources, including those related to viewpoint changes, signal values, and inevitable geometric distortions. For example, the ultrasound probe itself casts a shadow on the image, so when the probe viewing direction changes, so does the nature and location of the shadow. In addition, the ultrasound signal values themselves are variable. The resulting noise and blurring effects can occlude distinct features. Finally, body movement during the data-acquisition process (either related to the pressure and contact of the ultrasound probe or to the natural behavior of the sampled organ, such as a beating heart) can cause inconsistent geometric deformations.

To deal with the inherent variability of ultrasound data, the system developed by researcher Dror Aiger of MedSim uses a unique image-based registration technique that looks directly at the gray values of image pixels rather than attempting an



**Images of a building are depicted during various phases of the multiresolution registration/transformation process. Various resolutions produce different results in the ultimate transformation. The square added to the upper left-hand corner of the target image helps highlight the variation among the versions.**

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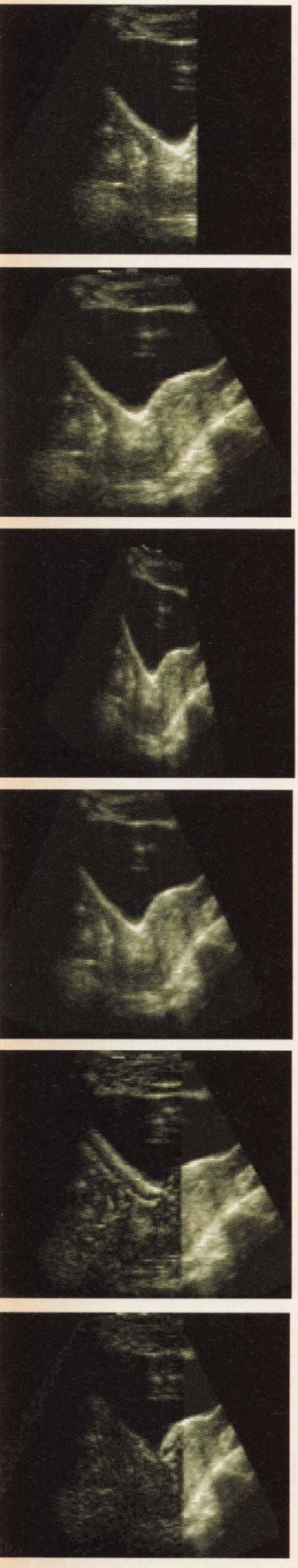


An automatic culling mechanism rejects irrelevant pixels in an acquired image, alleviating some of the noise and fuzziness. Here, an ultrasound volume is depicted before and after the culling process. The top two images show the ultrasounds being registered. Third is an example of their registration with no culling; fourth, one using the culling technique. The fifth image shows the difference between the top two images. The bottom shows the difference between the first and fourth images.

interpretation of those values, as is the case with feature detection. The method compares and registers the volumes based on the information contained within each pixel. Because some of the pixel information in each image carries no useful information (arbitrary noise, errant shadows, and so forth), the technique relies on a "majority" approach, in which the gray values of the pixels are considered in the context of the whole image rather than independently. Therefore, the success of the registration reflects the average success over the whole image.

The gradient-registration technique is based on the assumption that the pairs of volumes being considered are close enough for the mapping between the two to be expressed in terms of their gray values.

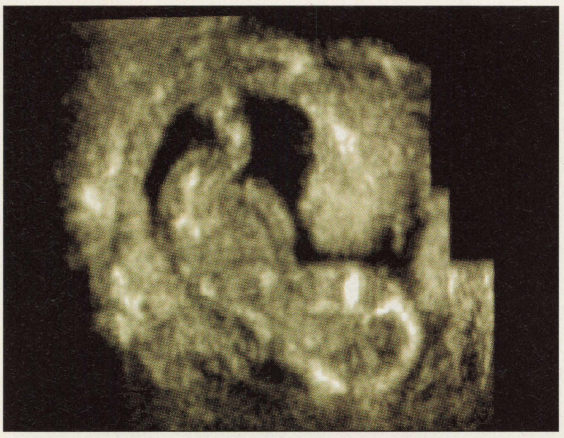
Getting "close enough" images is a function of the data-acquisition process. A good approach for achieving this, according to Aiger, is to attach the ultrasound probe to a mechanical motor that sweeps the slice along a trajectory. For example, a parallel sweep produces a series of parallel slices with no interslice gaps. Such dense slices provide small volumes of good quality.

Once the data has been acquired, the gradient-registration technique aligns and registers it using a two-staged process. The first step, called a coarse rigid transformation, registers one volume to another based on pixel correlations in the overlap portion of the volumes. To deal with larger-than-ideal gaps between the slices, a resolution pyramid enables the mapping between the volumes to be expressed in terms of their gradient values for coarse to fine resolution. The resolution pyramid comprises the original image and copies of it at increasingly lower resolutions. At lower resolutions, adjacent pixels and local gradients represent large distances between the target and the source images. Smaller gaps enable higher resolution.

The gradient-registration technique also incorporates a culling mechanism that eliminates from consideration all the pixels that don't have a matching counterpart in the other image or that are deemed by the system to be void of useful information based on statistical data from the pixel's neighborhood. Removing pixels that are irrelevant to the solution significantly improves the registration of partially occluded or generally noisy scenes.

The second step in the transformation process is a fine-elastic warp that extends the gradient registration to 3D and warps the data based on the elastic content (from body movements) of the volume.

To create the 3D volume representation, the newly warped volume is "stitched" over the reference volume. The size of the ultimate mosaic is limited only by the main memory of the workstation on which it's being composed and generally depends on the application for which the visualization is intended. For example, MedSim has patented the technology for use in a real-time ultrasound-based visual simulator that it has developed for medical training. With the system, students learn how to identify and diagnose a range of medical conditions by operating a simulated ultrasound device on a mannequin. For this application, says Cohen-Or, "the mosaics let us build a database large enough for training purposes."

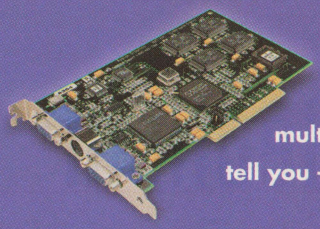


A volumetric mosaic of a weeks-old fetus was developed by registering overlap regions of ultrasound scans based on correlations of gray values among the collected images. This is a cross-section of the mosaic.

In addition to the ultrasound simulator, other medical ultrasound applications of the technology include the development of a 3D anatomy atlas, says Cohen-Or. "It can also be used for the analysis of large organs, where a diagnosis has to be based on an area that can't be seen in a single shot with conventional 3D ultrasound scanners."

The gradient-registration/image mosaic technique is not limited to medical ultrasound. In fact, says Cohen-Or, "it can be used as a general direct method for image registration for any type of noisy images. [MedSim] is considering its use in clinical [medical ultrasound] equipment, but it can also be used for such common applications as stitching together several photographs to build a panoramic view of a scene."

*Diana Phillips Mahoney is chief technology editor of* Computer Graphics World.



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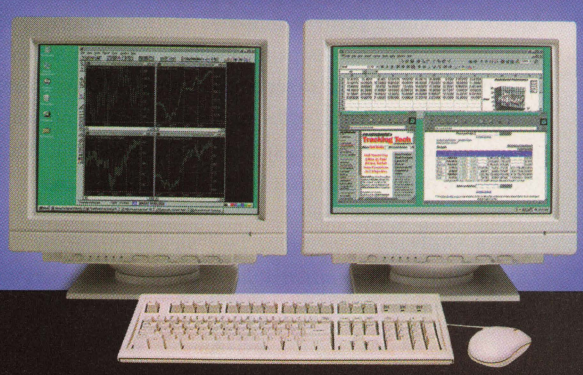

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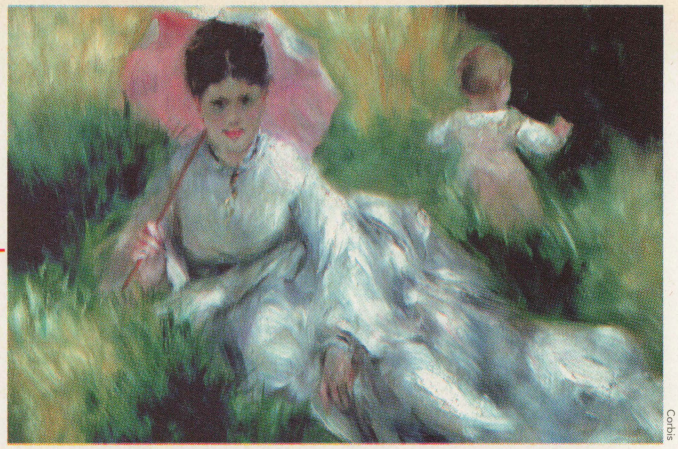
# Beyond Realism



CG films may soon incorporate nonphotorealistically rendered characters and objects as appealing as the figures in impressionist paintings like Renoir's "Woman with a Parasol and a Small Child on a Sunlit Hillside."

Corbis

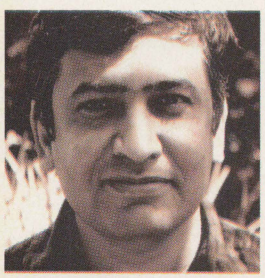
"In a new age, new techniques. It's a simple matter of good sense," remarked French writer and critic J.K. Huysmans after witnessing the new art movement called impressionism in the year 1879. These words might well be repeated today with respect to computer-generated imagery, which continues to carve new visions into human minds. As computers bulldoze their way through the various visual art forms, they also challenge established methods of communicating thoughts and ideas.

Looking back, it seems that one of the greatest challenges the various visual art forms faced as they surfaced was their ability to depict realism. Renaissance art, which began in Italy approximately 700 years ago, stressed the classic forms of antiquity as well as a realistic representation of space based on scientific perspective. The works of Leonardo da Vinci, Michelangelo, and Raphael, with their emphasis on precise anatomical representation, are among the best examples of this kind of endeavor.

Some 200 years after the end of the Renaissance, in the late 1860s, Monet, Pissarro, Renoir, and others began painting landscapes and river scenes in which they recorded their impressions of colors and forms rather than line-for-line representations of them. The objects in their paintings began to shimmer and vibrate with light and color as the artists attempted to depict the spirit of reality rather than its mirror.

In modern times, the use of computer imagery in film has followed a somewhat similar path. Until recently, the main emphasis in producing digital imagery (and by this I mean primarily 3D imagery) for movies has been to simulate reality. This enormous challenge has led to the invention of various graphic techniques and tools, and Hollywood films have become the final seal of approval in establishing the ability of computers to meet it. Audiences worldwide have been amazed by the lifelike dinosaurs in *Jurassic Park* and by the credible digital world created for *Titanic*.

**To gain the status of fine artists, CG animators must follow the example of the impressionists**



BY UMESH SHUKLA

But is depicting reality all computers are capable of in the world of film? Can we use them to create nonrealistic images with an artistic and entertainment value all their own? I would argue that we can and that we have even taken the first steps in this direction. The influence of computer-generated animation is even now being seen in otherwise traditionally animated movies. Two examples are the parting of the Red Sea sequence from *The Prince of Egypt*, where 3D graphics were used to create the imposing walls of water, and the lush, painterly 3D jungle in *Tarzan*, through which the 2D apeman swings. In visual terms, *A Bug's Life* and *Antz*, both completely animated feature films, go a bit further toward providing a non-photorealistic style of digital imagery, albeit in a recognizable cartoon-like style.

## A Direction for Digital Imagery

How much further and in what direction should we go? Perhaps if we return to the way painting evolved as an art form, we can find some clues. Before artists like Leonardo da Vinci and Michelangelo raised the status of painting during the Italian Renaissance, it was considered a craft rather than an art form—an activity akin to manual labor that dirtied the hands. It lacked the scholarly status of music, mathematics, and literature. In reaction to this perception, art academies begin to teach only the most intellectual aspects of art; the scientific study of anatomy, the geometry of perspective to construct an illusion of space, and drawing, and the successful imitation of raw nature soon came to pass. When the impressionists emerged centuries later, the art world establishment initially refused to take their work seriously. Eventually, however, many of the impressionists were able to ascend to the status of fine artists in their own lifetimes.

Today, in film, we have the reverse situation. The realistic depiction of objects has conferred on their creators the label of technicians rather than artists. I believe that in order to gain status as fine artists, CG animators need to follow the example of the impressionists and begin presenting alternative interpretations of reality. I am sure that soon a group of computer animators will emerge who will be no less impressionistic in spirit and enthusiasm, who will boldly go where no animator has gone before. Alexander Petrov's animated 2D Imax short "The Old Man and the Sea," with its paint-on-glass technique, achieved the kind of imagery I expect to see being created in 3D. And I am sure that many other visual styles, as yet undreamed of, will soon arrive on movie screens to expand our experience and appreciation of the medium beyond current imagination.

*Umesh Shukla is a technical lead for digital effects at Walt Disney Feature Animation and a former CG supervisor for Digital Domain.*

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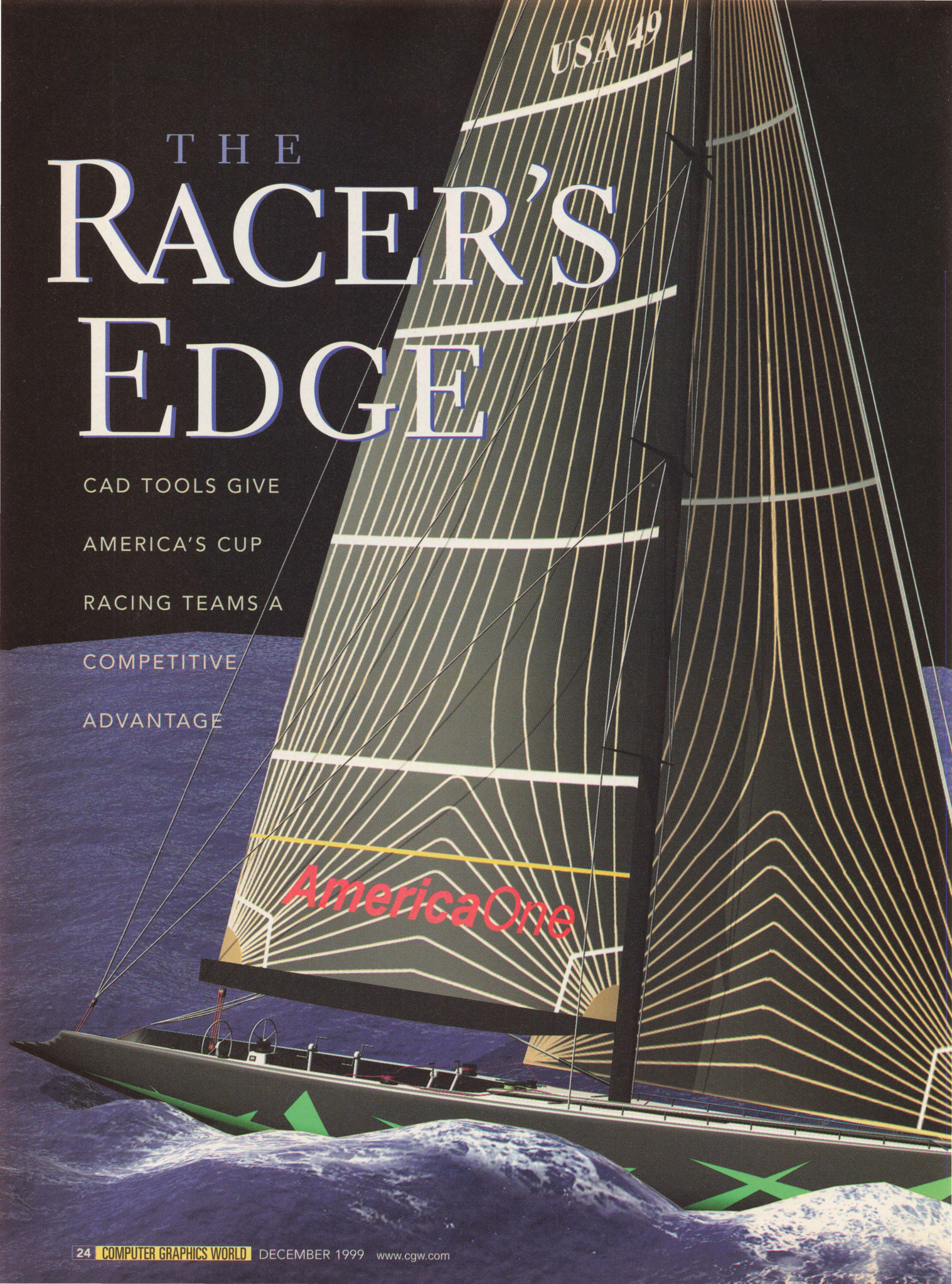
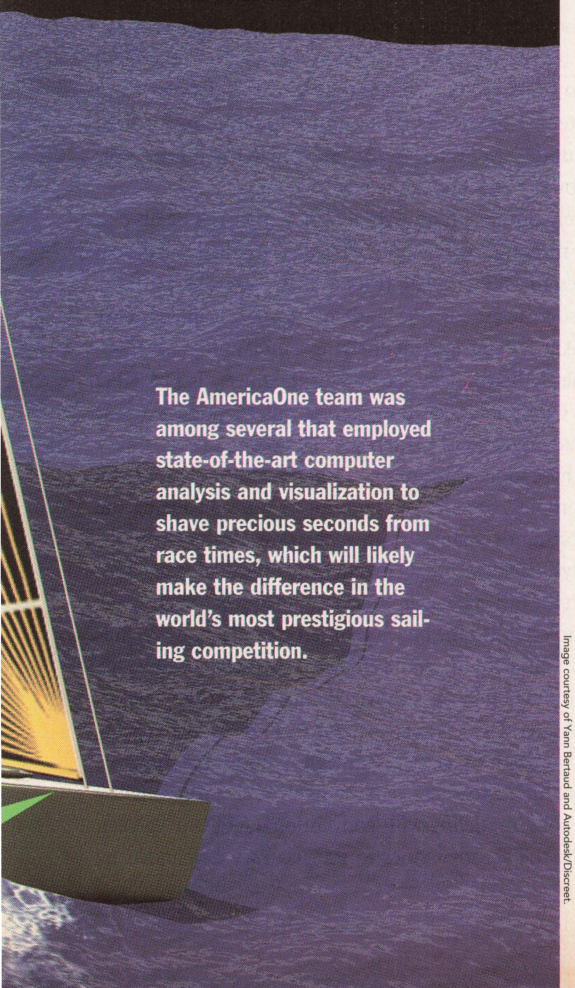



# THE RACER'S EDGE

## CAD TOOLS GIVE AMERICA'S CUP RACING TEAMS A COMPETITIVE ADVANTAGE

Image courtesy of AmericaOne.

**Most if not all of the 11 contenders for the America's Cup, including AmericaOne (above), used CAD to design the fastest fleet in the history of the competition.**



**The AmericaOne team was among several that employed state-of-the-art computer analysis and visualization to shave precious seconds from race times, which will likely make the difference in the world's most prestigious sailing competition.**

Image courtesy of Yann Bertaud and Autodesk/Discreet.

Winning the coveted America's Cup international yachting race entails more than skilled seamanship. Over the last decade, the world's most prestigious boating event, held approximately every four years, has evolved into a technology-driven challenge that is often won or lost long before the contenders begin sailing. Indeed, the real race occurs during the planning and building of the world's fastest sailboats, because an optimal boat design, in addition to the wind, waves, and skill of the crew, can determine who will cross the finish line first.

Since the beginning of the 150-year challenge, design innovation has played an important role in the competition's outcome—from the 1851 win of the swift schooner *America* over England's traditional fleet to the 1983 victory of the revolutionary winged-keel design of *Australia II*, which ended the New York Yacht Club's 132-year winning streak.

In fact, design innovation seemed to have been pushed a little too far in 1988, when the Stars and Stripes team protested New Zealand's fiberglass hull and its "big boat" design. The controversy led to the 1992 adoption of the International America's Cup Class (IACC) codes, which limit, among other things, boat length, weight, and mast size. Now, with all competitors building boats to the same general specifications, design innovation has become a struggle in minutiae, as the contenders try to find the optimal combination of fractional tweaks and changes, where a half inch here and a quarter inch there can provide the winning edge.

"The design work we're doing now is just as important as how the crew conducts itself on the water, because even a skilled crew can't make up for a boat that is slower than the competition," says Bob Billingham, chief operating officer of the San Francisco-based AmericaOne Team. "There's no question that the fastest boat will win this race—and you'll be talking about time differences of seconds."

During the last Cup challenge, held in 1995, Team New Zealand was the group that best capitalized on the benefits of computer-aided design technology—not only to draft boat specifications for various parts of its vessel, but also to test them by simulating real-world racing conditions. As a result of its innovative step in embracing digital design tools, the group will be defending the Cup during February in Auckland, New Zealand, against the winner of the four-month round-robin Louis Vuitton Cup, which determines the challenger.

## Breaking with Tradition

"This time around, I believe there are quite a few other racing syndicates using CG analysis and visualization, so now we may well be one of the boys rather than the leader in this area," says Tom Schnackenberg, design coordinator for Team New Zealand. His prediction seems accurate, as many of the challengers are following in the defender's technological wake. Among them is Italy's Team Prada, whose designer, David Egan, is building on the expertise he gained as a member of the 1995 New Zealand team. "In 1992 and 1995, there were probably only one or two other syndicates, besides New Zealand, using things like graphic simulations. For this race, I imagine there isn't a single team that is not trying it," Egan says. "Those not taking advantage of this technology will be in trouble down in Auckland."

Yacht design has always been a traditional and conservative industry, and during the last race, people were still wondering where the technology fit in, says Egan. But now, most if not all of the 11 competitors for the America's Cup are using at least some type of CAD-related technology to

design their multimillion-dollar boats. However, some syndicates—such as Prada, AmericaOne, and New Zealand—have been exploring the technology's outer limits in an attempt to secure an advantage.

The tide is now turning toward using design analyses—such as computational fluid dynamics (CFD) and finite-element analysis (FEA)—coupled with 3D visualization techniques, as the racing teams realize the advantages to be had. These tools become especially important to the design process when the actual racing begins, since the teams are permitted to alter their boat's design during the competition. In fact, many groups opt to build more than one vessel for the event.

Billingham estimates that during the last two Cup races, computer modeling was used far less than the expensive physical wind-tunnel and tow-tank tests (to measure the drag of a scale model as it is towed through the water). "In this Cup, I think you will see those roles reversed," he says. "We now trust computer modeling software so much that it is taking the lead, while physical testing is used to back up those results."

The catalyst for achieving buy-in to the various design technologies, Egan maintains, is 3D visualization. "CFD and FEA were almost exclusively the domain of the top automotive and aerospace industries, not the yachting industry, so people remained skeptical about their use," he says. "It's one thing for someone like me to use the tools to design what I think is a really fast boat, but it's another for a naval architect or sailor to believe me and want to make those design changes. With 3D visualization, everyone can easily understand and trust the analyses."

## Going with the Flow

Fluid flow, says Team New Zealand's Schnackenberg, is one area where 3D visualization becomes most useful in determining an optimal design. Without visualization, we cannot see the movement of air and water, just the effects of disturbance. But by coloring areas of high and low pressure, "we suddenly have some understanding of this complicated phenomenon," he says.

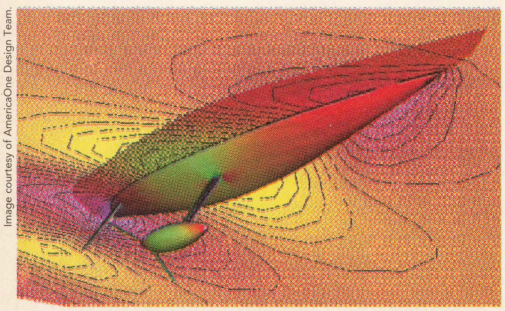


Image courtesy of AmericaOne Design Team.

**AmericaOne used a varied tool set to visualize water pressures on the keel and bulb of one of its boat designs. The varying pressures on the appendages are represented by different colors.**

For Team New Zealand, using sophisticated volume-rendering codes and tools, such as Fluent's 3D CFD software to model fluid flow, enables the team to visualize pressure maps over the hull, keel, wings, and even the sails, and then make changes to the boat design based on what is occurring. "We can make the wings bigger or move them backward or forward, and from the flow visualization, we can now understand how that may affect the boat's speed," says Schnackenberg.

The designers agree that almost any design change results from a combination of numerous minute tweaks that are measured in millimeters and fractional percentages, so it is virtually impossible to link a specific change to an increase in boat speed. Using analysis and visualization technology, however, enables the teams to test dozens of tiny changes and then determine whether the cumulative result improves overall performance, even if it's only by a second or two.

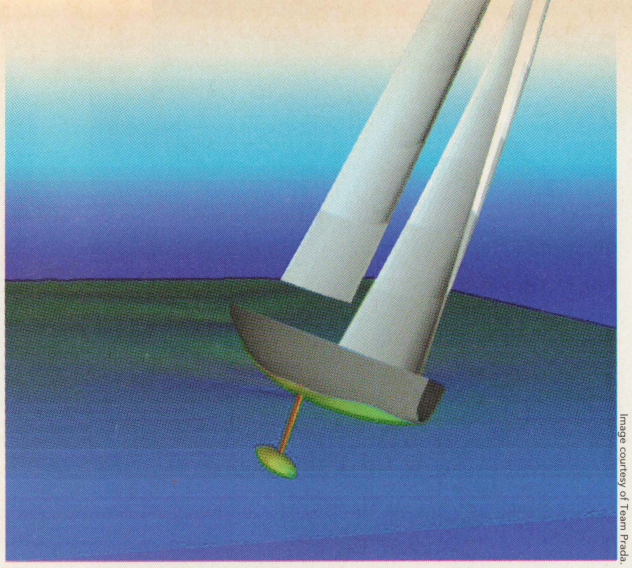


Image courtesy of Team Prada.

**Using an integrated software configuration, Team Prada employed ICEM CFD to dynamically update a simulated sea surface in PTC's Pro/Engineer, with which the group then determined and displayed the hydrodynamic loads on its yacht design.**

## Wind and Water

Perhaps the biggest challenge comes in analyzing the effects of both wind and water—two entirely separate phenomena. This crucial but difficult task requires a thorough understanding of hydrodynamic forces associated with the hull, keel, and appendages, and aerodynamic forces associated with the sails and mast. Robert Hook, sail designer for AmericaOne, likens the overall yacht design to building an airplane that is half underwater and half above water. "The trick is to minimize the amount of drag being created under the water and to maximize the horsepower being created by the sails above the water," he says.

Unfortunately, outside of the yacht industry, there is little need to concentrate on these dual constraints, which has resulted in a dearth of high-end design and simulation tools that serve this purpose. Consequently, some teams, such as Prada, are taking advantage of the newer open CAD systems and engineering simulation packages—such as Parametric Technology Corp.'s Pro/Engineer, ICEM CFD software, and Computational Engineering International's (CEI) EnSight—and adapting them to their specific needs.

Even with these tools, determining fluid flow for a yacht design is extremely complex, because the amount of water touching the boat surface constantly changes with each wave. Further complicating this analysis is the fact that current CFD offerings work independently from the other programs used in the process, such as the CAD software to establish the boat's geometry. Prada, however, has overcome this obstacle by establishing a pathway so that its Pro/Engineer modeling data, Pro/Mechanica structural analysis information, ICEM CFD mesh generator, and EnSight post-processing software work together seamlessly without the manipulation usually required to share data between each program. "By combining 3D solid modeling with conventional CFD, we've been able to compute the aerodynamics to the accuracy demanded by

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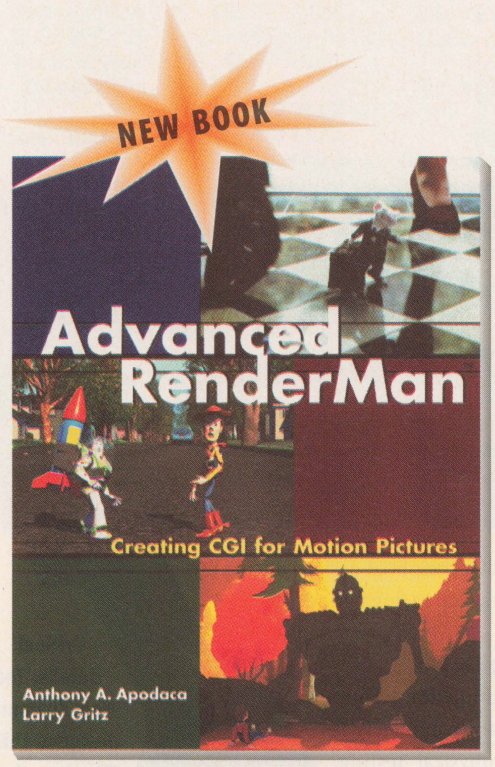


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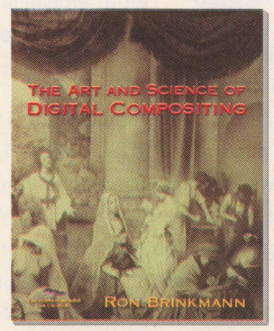


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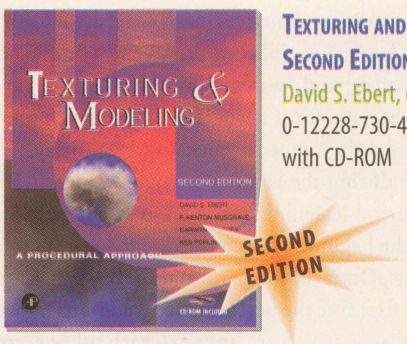


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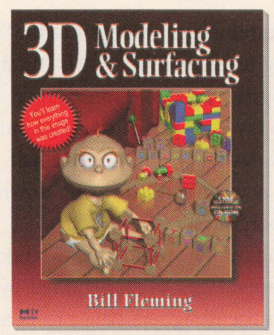


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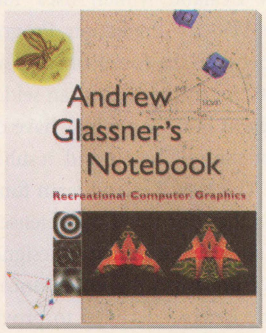


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the America's Cup race—something that's not typically done in the yacht-design process," Egan says.

This technique enabled Prada to accurately compute the area of the boat surface touching the water. "You're computing [the amount of water touching] the boat to within 1 sq. mm, which is necessary if you want to see the changes in drag that will make a difference," says Egan. In fact, just prior to the first round-robin, Prada designed a new keel that resulted in a change of 5 sq. mm of surface area, which may not seem like much, "but that's the level of detail that we were concerned with," he says.

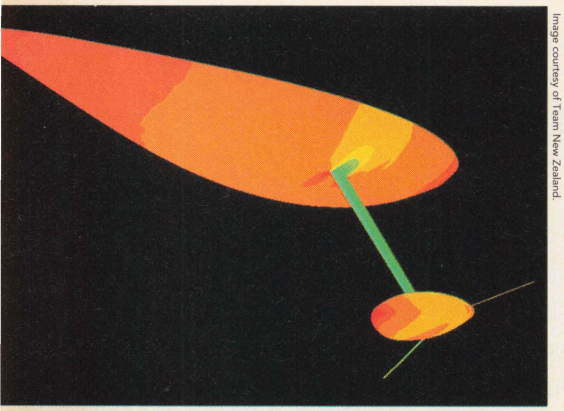

Image courtesy of Team New Zealand.

**Team New Zealand used computational fluid dynamics to identify regions of high pressure (shown in red) on the keel and bulb design of its boat.**

AmericaOne, meanwhile, is using a variety of commercial CAD, CFD, and visualization software along with proprietary simulation codes that have been developed at companies such as Ford Motor Co., Pratt & Whitney, and Science Applications International Corp. "Although the sailboat simulation problem represents a unique combination of hydrodynamic and aerodynamic effects, we have developed a system that combines existing capabilities in each of these areas, instead of trying to develop our own single system that does it all," says AmericaOne designer John Kuhn.

By using this approach, AmericaOne has created software that finds the operational equilibrium between hydrodynamic and aerodynamic forces, and "provides an indication of how a complete design performs for a specified set of environmental conditions that model the venue in Auckland," Kuhn says. This will play a key role during the lengthy racing period, when the group expects a general lessening of the wind strength. "So the design we want in the beginning is not the design we want to use at the end," AmericaOne's Billingham adds. This system also enables the team to examine the performance trade-offs between boat length and sail area, which are linked to each other according to the IACC rules.

And then there's Team New Zealand, which uses Yacht Research International's WinCup Velocity Prediction Program (VPP) to establish a relationship between the forces of wind and water. "When analyzing tank results, for instance, you can seldom consider the hull in isolation; different hull shapes may have different stabilities, and hence, affect the sail forces and resulting equilibrium," Schnackenberg says. The New Zealand team found the program so useful for analysis that, for this Cup defense, it invited the developer, Clay Oliver, aboard as a principal designer.

While Schnackenberg strongly emphasizes the importance of the program, he—like the other designers—declined to provide exact details concerning innovations uncovered during the design and analysis process, because competitors could use the information to alter their boat designs during the America's Cup racing period.

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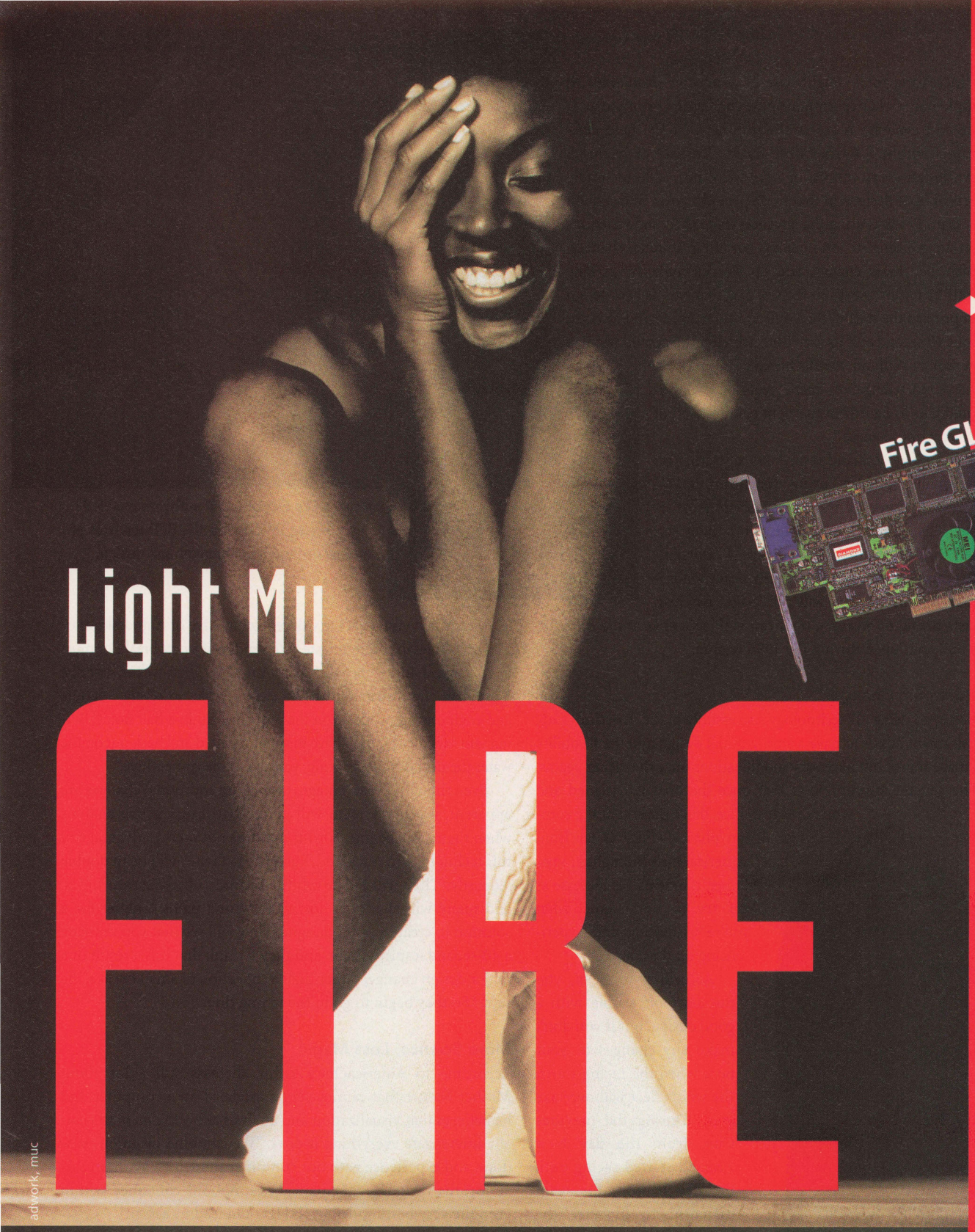
**Critical details: Team New Zealand designed this tiny titanium rigging bolt in SolidWorks and CosmosWorks FEA to withstand forces of 4 to 5 tons.**

### Drilling Down

While simulation technology has not completely replaced physical testing, thanks to the software and hardware advances within the last few years it is providing teams with advantages never before seen in the history of the America's Cup, such as the ability to analyze the entire boat. In 1995, the New Zealand designers were using the technology to analyze parts of the boat—hull, keel, and appendages. But now, Egan says, the design team at Prada is looking at the entire boat to answer questions such as, What kind of effect does wind angle have on the rudder angle? "Suddenly we are looking at the interaction of the whole design," he says. "We can drill down another layer and look at the secondary effects, and design an appendage, such as a rudder, not only to serve its primary purpose, but also to simultaneously benefit a different variable."

New Zealand, like Prada, is extending its analysis to the "sub-layers" of its boat design. Using team member Chris Mitchell's Access2 mast and rigging analysis program, for instance, gave New Zealand the confidence to try a variety of rigging configurations, which resulted in a new design. "A mast costs a half-million dollars, and if the rigging is wrong, it can bring down the mast very quickly," Schnackenberg says.

AmericaOne is also analyzing numerous design variations of the boat's hull, rigging, and appendages as constrained by the IACC rules. For instance, when the designers chose to increase the sail area to provide additional aerodynamic horsepower to the boat, they had to compensate for it by reducing boat length

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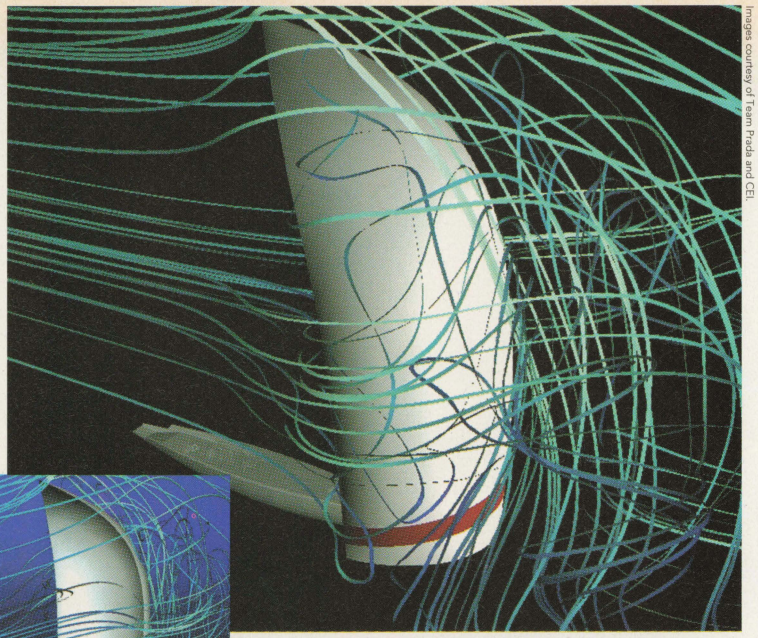
or increasing total weight. Use of computer simulation to supplement field experiments now enables the group to analyze and evaluate more configurations that fit these constraints within a shorter time frame. "Instead of having a new design every month or two, we're now able to model fleets of boat designs in that same period," notes Billingham.

Team Prada is using the advances in analysis and visualization to concentrate on making countless minute changes, which, like loose change, add up. For example, by making about 25 minor tweaks to the size and shape of its keel design just prior to the start of the Louis Vuitton Cup, Team Prada cut about 40 seconds off its race time, which it then could test in a tow tank. "Without this technology," Egan says, "there's no telling how many years of testing it would take to figure out the right combination of so many tiny changes."

Team New Zealand is also concentrating on the smaller picture, using visualization and analysis to improve the tiniest portions of its boat. The failure of one little component can spell disaster, Schnackenberg says. If the sailboat cannot sustain the extremely heavy loads it incurs, a component will fail. Sails can tear, masts break, or worse, a boat can sink, as *oneAustralia* did after its hull split open during the 1995 regatta.



Images courtesy of Team Prada and CEI.

**Using CEI's EnSight CFD software enabled Team Prada to visualize the CFD analysis of airflow around its spinnaker sail design.**

## Midstream Changes

The key to using 3D technology successfully in the America's Cup, Egan maintains, is to have a strong initial design and the flexibility to make minor but necessary modifications once the racing begins. "The general assumption is that once the boat is designed and you're ready to race, that's the end of the computer design phase—which is far from true," AmericaOne's Billingham says. "Rather, the demands increase as you try to understand what you're witnessing and experiencing on the course."

According to Egan, you can start off strong with a good design, but if you don't make any changes to your boat when the racing starts, the whole fleet will overtake you. "During the previous Cup, from the day New Zealand started racing until the day it won, the team managed to increase the boat and crew speed by more than four minutes," he says. "So all the tuning Team New Zealand did on the yacht during the trials was as critical as all the design work we did up to that point."

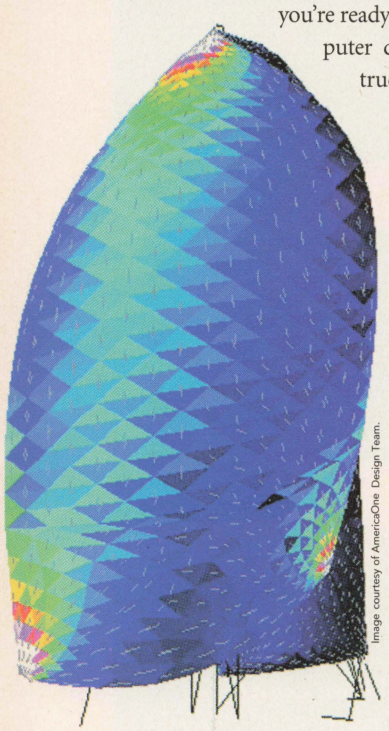


Image courtesy of AmericaOne Design Team.

**AmericaOne used proprietary simulation codes to analyze the various pressures on its spinnaker during a downwind course.**

Meanwhile, AmericaOne will rely on its base of Autodesk AutoCAD 2000 files to communicate with vendors if a part breaks or must be redesigned during the race. "With AutoCAD 2000, we can describe a problem and distribute the files electronically so several vendors and engineers are working on the problem within a half hour," Billingham says. "If you can't have the boat repaired and back out on the water the next day to go racing, you cannot be competitive."

Even though the advantages of making additional changes are apparent, not every team will commit to using active analysis when the racing begins. For those teams not taking advantage of this technology in Auckland, Egan predicts they will be in double jeopardy: They will fail to whittle seconds off their race times, and many will also turn down the wrong paths looking for a solution to create a faster design. "They will see that you've made a 40-second improvement, and they'll think that it is a result of a major design change, rather than a collection of small tweaks," he says. "So they begin to go in the wrong direction."

## More Science, Less Magic

According to AmericaOne's Kuhn, there is still a lot about Mother Nature that cannot yet be modeled on a computer. But he believes that visualization and analysis allow the team to visually interrogate everything it does. "We combine intuition, wisdom, and experience with our computer modeling. Without this ability, the various mathematical assumptions contained within even the very best modeling codes could lead us astray."

As computer-aided design and analysis technology becomes more robust, the designers expect that syndicates' reliance on it will become even greater in the future. "A hundred years ago, yacht design was 100% magic and 0% science," Egan says. "Over the years, those ratios became more balanced, and now, for the first time, computer simulation is helping us to understand that magic."

*Karen Moltenbrey is an associate editor* at Computer Graphics World.

*Old Penn Station, by David Beker (3D Studio MAX)*

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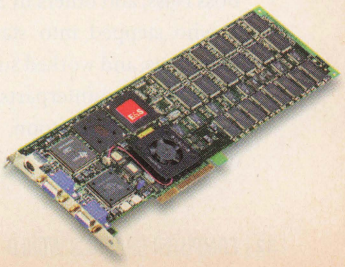

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# Building a Better Mouse

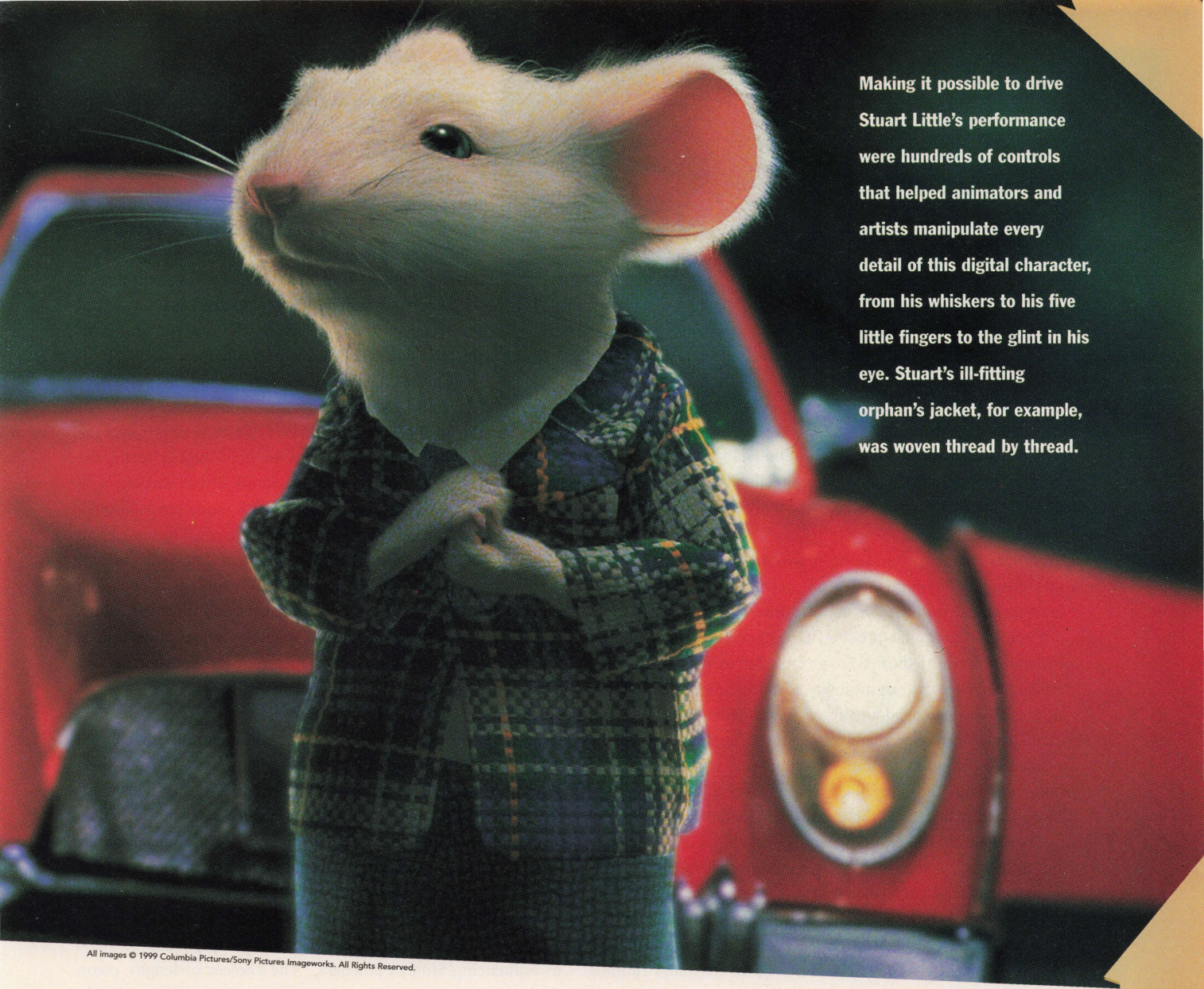
THE DIGITAL STAR OF THE LIVE-ACTION FILM STUART LITTLE CREATED NUMEROUS TECHNICAL CHALLENGES FOR THE VISUAL EFFECTS CREW AT SONY PICTURES IMAGEWORKS

BY BARBARA ROBERTSON

Each year computer graphics artists nudge the state of their art closer toward the creation of a virtual film star that could work alongside human actors. On one branch of the evolving digital family tree we find animal stars created with computer graphics that are real enough to fool the eye—cockroaches, penguins, bats, birds, lions, zebras, elephants, monkeys, apes, and even digital humans seen from a distance. On another branch, we find such characters as Casper, the dragon in *Dragonheart,* and Jar Jar Binks, Watto, Boss Nass, and others in *Star Wars Episode I,* who stepped into starring roles, said their lines, and worked successfully alongside human counterparts in feature films. But Casper is a cartoon. Draco, the dragon, is a photorealistic fantasy animal. And while the *Star Wars* characters act something like humans and even wear clothes, they don't look like anyone recognizable. Thus, on one branch we have the evolution of photorealistic digital beings from the real world and on another, the evolution of digital fantasy beings with starring roles and speaking parts. This month, a digital character named Stuart will step onto the big screen and bend the branches a little closer together.

Created at Sony Pictures Imageworks (Culver City, CA), Stuart Little looks like a mouse but walks, talks, and dresses like a human child. Based on E. B. White's children's book, *Stuart Little,* the Columbia Pictures/Sony Pictures Entertainment film of the same name is directed by Rob Minkoff, who co-directed *The Lion King.* It stars Hugh Laurie and Geena Davis as Mr. and Mrs. Little, and Jonathan Lipnicki as their young son George.

As the movie begins, George is excitedly saying good-bye to his parents, who have promised to bring home a brother. But at the adoption agency, the roomful of orphans overwhelms the Littles—until a small mouse tries to help. Stuart, the mouse-child, wins the Littles' hearts, and despite a warning from a counselor that it would be better to adopt within their own species, they adopt him. Thus, Stuart finds a new home in a brownstone on Fifth Avenue, to the dismay of his new younger brother George and the horror of the house cat Snowbell, who grunts, "They go for a son and come back with a mouse. I need a drink." From the first moment Stuart appears onscreen until the last minute of the movie, he and his human co-stars must convince the audi-



**Making it possible to drive Stuart Little's performance were hundreds of controls that helped animators and artists manipulate every detail of this digital character, from his whiskers to his five little fingers to the glint in his eye. Stuart's ill-fitting orphan's jacket, for example, was woven thread by thread.**

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ence that he is as plausible a member of the family as the Littles believe him to be.

"In visual effects, each film has to be a big challenge, or it's not fun," says John Dykstra, senior visual effects supervisor, who won an Oscar in 1977 for creating special photographic effects in *Star Wars*. "If I know how to do everything when I start on a film, then I'm using obsolete technology."

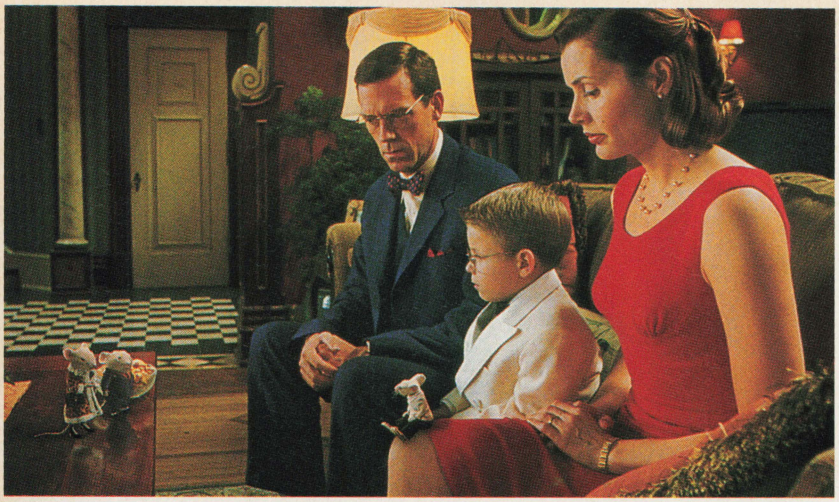
## Small Mouse, Big Challenges

Stuart's performance would be a big animation challenge; his fur and clothes, big technical challenges. He had the title role; it all had to work. "It was a huge risk," Dykstra says. "We said, 'Of course we can do it,' but in the back of my mind, I'm thinking, 'how the hell am I going to do this?'" He hedged his bet by having animatronic figures ready, but the puppets were rarely used. "It turned out that the CGI character was more cost- and time-effective and more flexible," Dykstra says.

In fact, the digital Stuart appears in 500 shots. "We have a couple shots with the animatronic stunt double in the radio-controlled model car," says Jay Redd, one of four CG supervisors. "But when he turns his head, he's CG." The CG Stuart is in daytime and nighttime shots, indoors and outdoors, up close and personal, and appears alongside human actors and real cats with real fur. Stuart's fur and his costumes must be believable, and to make that more difficult, sometimes they're wet. If that weren't enough, Stuart's "real parents," Mr. and Mrs. Stout, had to be modeled, animated, furred, and costumed as well.

"There were six aspects that we had to get right," says Dykstra. "We hoped we could get four, any four. I think we maybe hit all six." One aspect was creating lip synch for the cats, whose mouths were modified and animated `a la *Babe* for the scenes in which they talked. For this, the effects team relied on Centropolis Effects (Culver City, CA) and Rhythm & Hues (Los Angeles, CA), two studios with techniques and artists in place for making live animals look like they're talking.

The other five aspects centered on Stuart and the handful of shots with the Stouts. Good match-moving tools and techniques gave the director of photography freedom to film live-action scenes as he wished, yet provided the technical staff enough data to replicate the scene in 3D for the animators. The fur had to make Stuart look like a living mouse, not a stuffed animal. The clothes had to fit and move properly, or he would seem like a doll. Character-animation tools had to give animators the freedom to focus on



**Particularly difficult to animate were the oddly shaped Mr. and Mrs. Stout, Stuart's "real parents," shown here meeting the Littles: Hugh Laurie, Geena Davis, Jonathan Lipnicki, and Stuart (Michael J. Fox).**

creating a personality and performance for Stuart. And rendering, lighting, and compositing techniques were needed to blend Stuart flawlessly into the live-action scenes.

Some 127 computer artists, CG supervisors, and technical people were on the dedicated Stuart crew. Stuart's personality and performance were the responsibility of animation director Henry Anderson, who managed a team of 30 animators. Jerome Chen, visual effects supervisor, managed the rest of the CG process, the so-called "pipeline." The four CG supervisors worked directly under him with the help of 32 color, lighting, and composite artists, 15 cloth technical directors, five programming technical directors, 12 technical assistants, and "probably a dozen" people from R&D, according to Chen. In addition, the effects crew included another 40 to 50 artists helping out on occasion.

The principal software used to create and animate Stuart was Alias|Wavefront's (Toronto) Maya, which ran on both SGI (Mountain View) Irix and various Intel-based machines running NT for character animation and exclusively on SGI Irix workstations for everything else. Additional software used at Imageworks included Avid's (Tewksbury, MA) Matador for texture painting, Side Effects' (Toronto) Houdini for effects, Science.D.Visions' (Dortmund, Germany) 3D Equalizer for 3D camera tracking, Pixar's (Pt. Richmond, CA) RenderMan for rendering, Alias|Wavefront's Composer for compositing shots with Stuart, and Discreet's (Montreal) Inferno for compositing the cats. In addition, the studio developed stand-alone code and many proprietary plug-ins and macros to extend and customize the commercial packages.

## The Way It Worked

The process began with principal photography. On the set, the actors practiced with mouse maquettes, but during filming the maquettes were replaced with laser dots. The laser was, cleverly, synchronized with the camera's shutter so that no dots would be recorded on film. After each take, three reference balls were filmed: a chrome ball to capture highlights and environment maps that were used in Stuart's eyes, and white and gray balls that provided lighting information. As it turned out, the technical directors lighted Stuart like the other stars, using rim lights, for example, instead of the information from the white and gray balls. "When we matched the lighting on the balls, Stuart looked like a prop," says Chen.

The negatives from the live-action shoot were scanned using a 10-bit logarithmic color space, color timed to provide color consistency, then given to the match movers. Using Maya to model the scene, and 3D Equalizer to track the position of the live-action camera, the match movers created a 3D environment with a virtual camera that provided an exact match of the scene as it was filmed by the real camera. With this, the stage was set for the animators.

The animators worked with a modified version of Maya that had specific controls for Stuart's body (or the Stouts) and with dozens of face shapes. Once the animation was approved in gray-shaded form, the match-move data was turned off, Stuart was converted to a high-resolution NURBS model and skinned, then given fur, a costume, and lighting.The last step in the 3D process was the rendering of layers of data as 2D images that were composited with the live-action footage. Depending on the shot, Stuart's head, eyes, whiskers, mouth, teeth, shirt, hands, and three types of shadows might be rendered separately. "We wanted to control each layer in compositing," Chen says.

## Cute Fur

Long before filming began, research and development were well under way, with some of the crew moving directly from their work on the movie *Contact* in December 1997 to begin developing Stuart. Stuart had to look like a mouse, but he also had to look cute. By giving Stuart bigger eyes than a real mouse, rounding the shape of the ears and making them furry, and putting fur on his tail, the artists, designers, and effects team managed to keep him looking like a real mouse—but not too real.

Fur, a big technical challenge, became as important as shape in influencing Stuart's cuteness. "The choices of length, color, thickness, whether it's oily and coarse or soft and fuzzy, all help create the perception of Stuart as charming and cute," Chen says. Although it was hard to predict which combinations would work, once they hit the right mix, they all knew it. "I remember the day when everyone ooh'd and aah'd," he says. "Stuart

**Although props that Stuart held, such as his toothbrush, were modeled, his vanity is a miniature physical model.**

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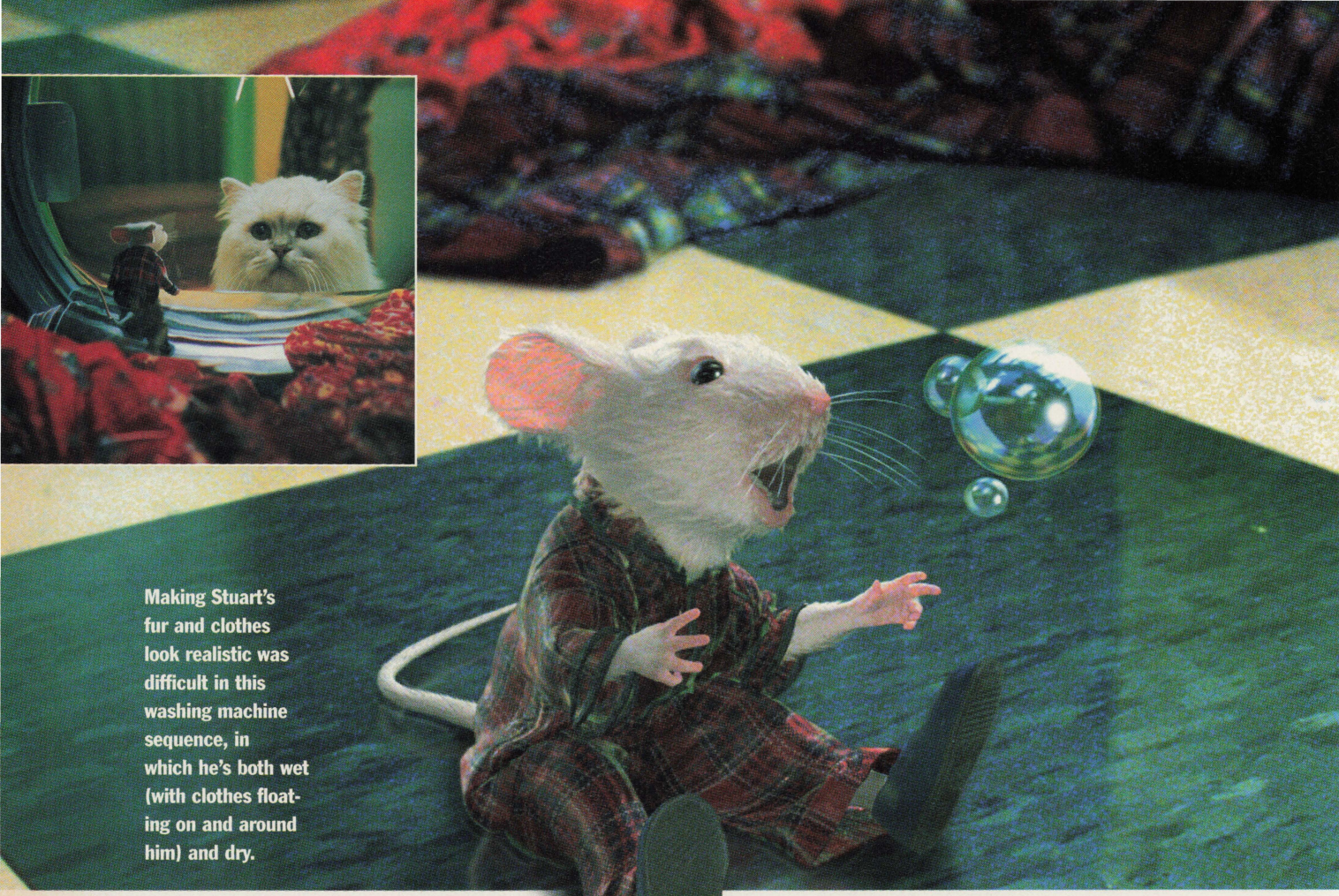

**Making Stuart's fur and clothes look realistic was difficult in this washing machine sequence, in which he's both wet (with clothes floating on and around him) and dry.**

changed very little after that." That final mix put about 450,000 hairs on Stuart's head, with nearly one-third on his ears alone. As in real animals, the length of Stuart's hair varies, his coat has slight variations in its whitish color, and he even has guard hairs. Unlike real mice, the hair above Stuart's eyes is a little darker to give a hint of eyebrows. The Stouts' hair is similar, although their fur is about 10% redder.

To create the hair, Imageworks' R&D team ruled out the few commercial hair and fur solutions available at the time and began developing tools specifically for Stuart. The resulting toolset, comprised of stand-alone code plus RenderMan DSOs [dynamically shared objects] and MEL scripts/plug-ins for Maya, provided a flexible mix of modeling and rendering techniques. The MEL scripts and Maya plug-ins helped define base geometry—a parametric curve with data specifying width and taper at each control point; the stand-alone code then calculated the features of individual hairs. Final hairs were drawn and rendered using RenderMan 3.7's RiCurves primitive calls and special hair shaders. The RiCurves primitive is a series of micropolygons along a curve in a ribbon-like shape that looks 3D and always has its widest part pointing at the camera. "We found we could create about 700 RiCurves [hairs] with one procedure call," says Armin Bruderlin, senior software engineer. "And by using RenderMan's DSOs to create hair at render time, the individual hairs don't show up in files. RenderMan 3.7 saved us a lot of headaches. If we had explicitly created all the hundreds of thousands of hairs for each frame, we would have had lots of large files."

For hair styling, the studio developed its own code. Using the Imageworks software, the hair stylists can specify the curl and orientation of the hairs and can vary the color, length, wave, twist, transparency, and density of hairs in particular areas.

As for animation, the underlying skin usually controls the movement of Stuart's hair. However, hair that gets wet is directly controlled. If the wet hair is animated, the amount, shape, size, and density of clumps are controlled through Maya. If it's static, texture maps are used to specify clumping areas, percentages, and rates over a series of patches; a stand-alone module translates the shades of gray painted in these maps into clumping controls. With this combination of tools, the artists can do something as specific as change the hair under a teardrop as it rolls down Stuart's cheek, or dot his fur with water when he's splashed while sailing on the lake in Central Park.

## Costuming the Star

A second big technical challenge was Stuart's clothes. Working with a maquette, costume designer Joseph Porro tailored 12 costumes for Stuart and the Stouts, many with multiple layers of clothing, then delivered patterns and cloth samples for all the costumes to the cloth technical directors (TDs). The cloth and the patterns were scanned and traced, according to Jim Berney, CG supervisor, who helped develop Maya plug-ins to stitch the pieces together and fit them onto Stuart's model. Then, Maya Cloth's simulation software moved the clothes dynamically. Once the dynamics were tested, the TDs added textures, all fashioned procedurally with custom RenderMan shaders. To create

*The Guardian*, created with MetaCreations Carrara™ by artist **Heather Dunnigan** ©1999

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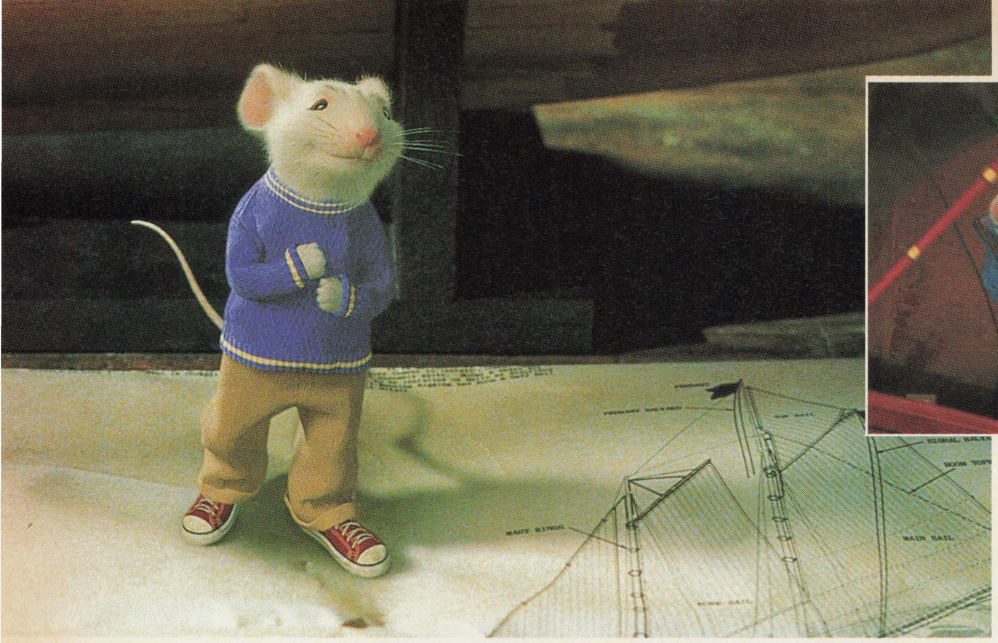
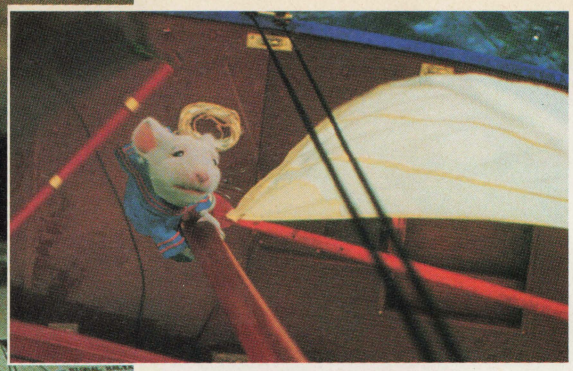




**Wearing doll clothes that fit better, Stuart strikes a typically concerned-yet-determined pose (left). On the boat (above), Stuart's animation and effects crew had to deal with the impact of wind and water on his fur and sailor suit.**

Stuart's plaid jacket, for example, a shader would weave colored threads into cloth, even adding bumps to simulate texture.

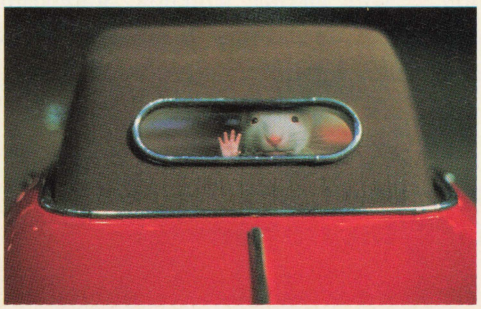
Rather than run one lengthy simulation, which would have to be run again if something didn't look right, the technical directors ran several variations at the same time on separate processors." We rarely got a perfect result from one, so we'd take what worked from each and blend them together," Chen says. "Going with Maya Cloth was a gamble because we had to work with alpha code. But we decided to because it wouldn't limit Stuart's performance." And Stuart's performance is, of course, critical to the success of the film.

## No Limits

Henry Anderson, who directed Stuart's animation, says of Stuart: "He doesn't really look at himself as a mouse. He is never driven by his limitations. I always thought of him as a little guy." Unfortunately for the animators, although Stuart needed to emote like a human, his face is shaped differently. "We had dozens and dozens and dozens of face shapes," Anderson says. "By mixing and matching and blending these shapes using sliders, we could create an infinite number of expressions."

As for overall performance, although Michael J. Fox provides Stuart's voice, Bill Irwin, a mime brought into the studio and videotaped, provided the vocabulary for his body language. The animators also used Stuart's hands, tail, and whiskers to convey emotion. "We worked a lot with the fingers," Anderson says. In one scene, for example, Stuart is about to be introduced to the relatives. He comes to the railing of the staircase and as he says, "Boy, that's a lot of Littles," he drums his fingers on the rail. When Stuart is sad, his tail drags on the ground. If he is agitated, it flicks. Similarly, his whiskers droop when he's sad or concerned.

All the animation was done in Maya using what CG supervisor Scott Stokdyk calls a fairly traditional skeleton setup with joints. "We used a combination of forward and inverse kinematics, bound the skin to the skeleton, and used deformers to deform the skin based on the movement of joints," he explains. However, the clothes sometimes made a difference. "We cared about interpenetration of the clothes and we didn't care what the body looked like underneath, so, for example, if an arm came close to penetrating the chest, we'd put a deformer in to cave the chest," he says.



## Fitting In

To make it easier for Stuart to interact with his environment, many of the props he touched were created with computer graphics. To integrate Stuart into his environment, a combination of effects, lighting, shading, and compositing were used.

For example, when Stuart touches something soft, he makes an impression. For effects work such as this, Stokdyk's team used Houdini, which, in this case, helped deform the real world in the live-action plate. Most of the integration was accomplished with lighting, though. The TDs extended the illumination model in RenderMan so that surfaces and lights could react to each other, creating, for example, translucent skin and more natural-looking hair. "Phong shading is not enough," Redd says. "Light is diffused by every piece of hair and if the hair is transparent, it's diffused again." Also helping to put Stuart into the environment were multiple layers of shadows. And once all those elements were rendered, the compositors began their work. "We'd get the rendering close, but the render times were so heavy, we set up little tools in Composer to do things like brighten and darken different areas of the mice in post," says Stokdyk.

"This was meticulous work," says Redd. "Even the rivets in Stuart's shoes had reflection maps. Sometimes you just have to keep trying, and that can be tough on artists."

"It is tweaky stuff, 'finesse-y' stuff," agrees Dykstra. "There are so many subliminal cues that can make it seem wrong."

But all indications are that this crew got it right. If so, it's possible that Stuart will achieve something few digital characters have accomplished: a strong emotional tie with the audience. If you see anyone watching the movie get a tear in his or her eye, you'll know that the evolution of digital characters has most definitely taken another step.

*Barbara Robertson is Senior Editor, West Coast, for* Computer Graphics World.

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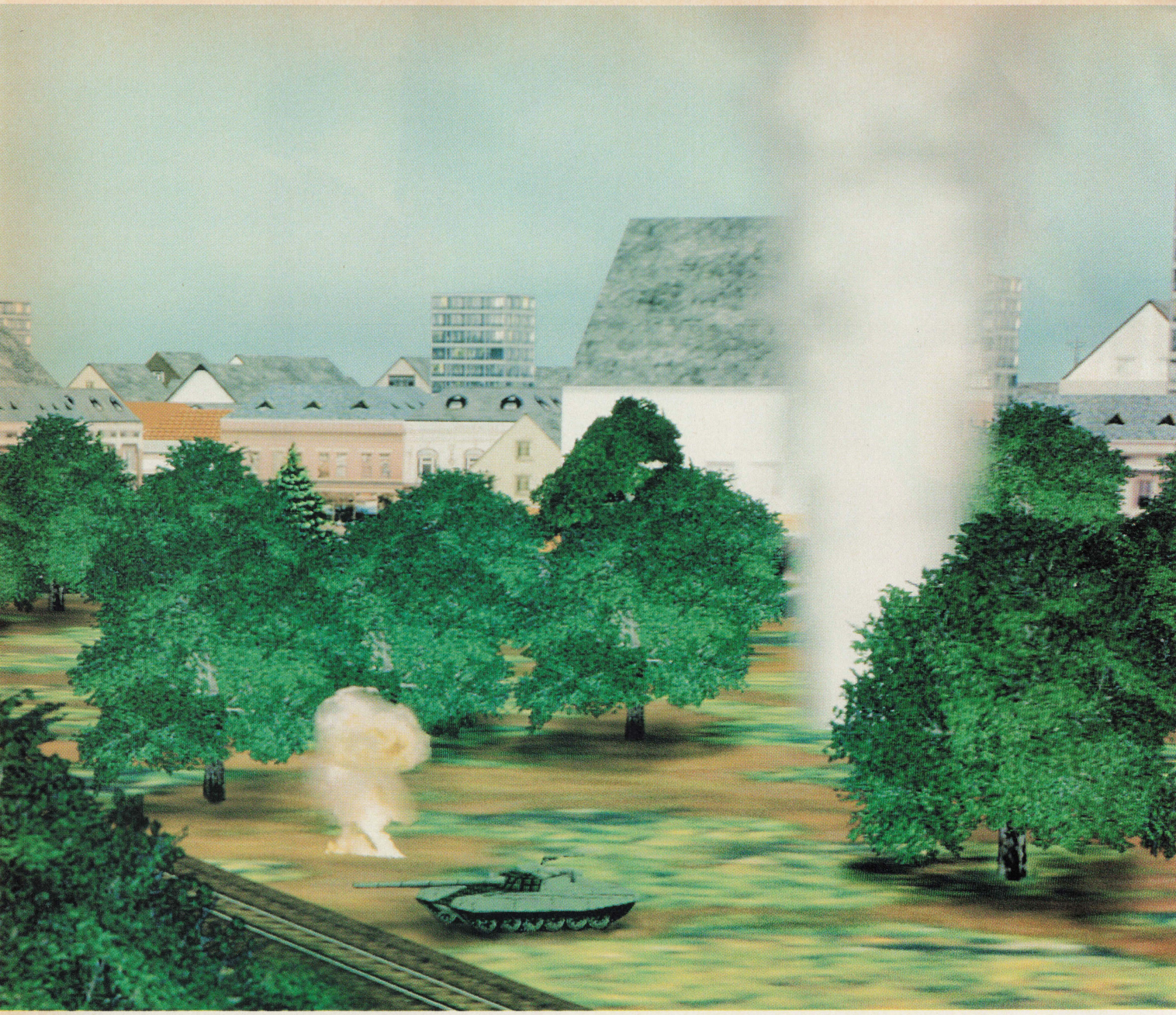

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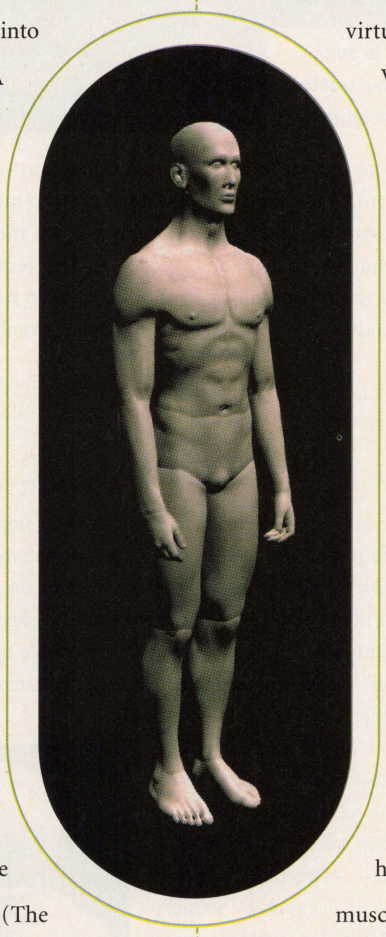
# deadmanwalking

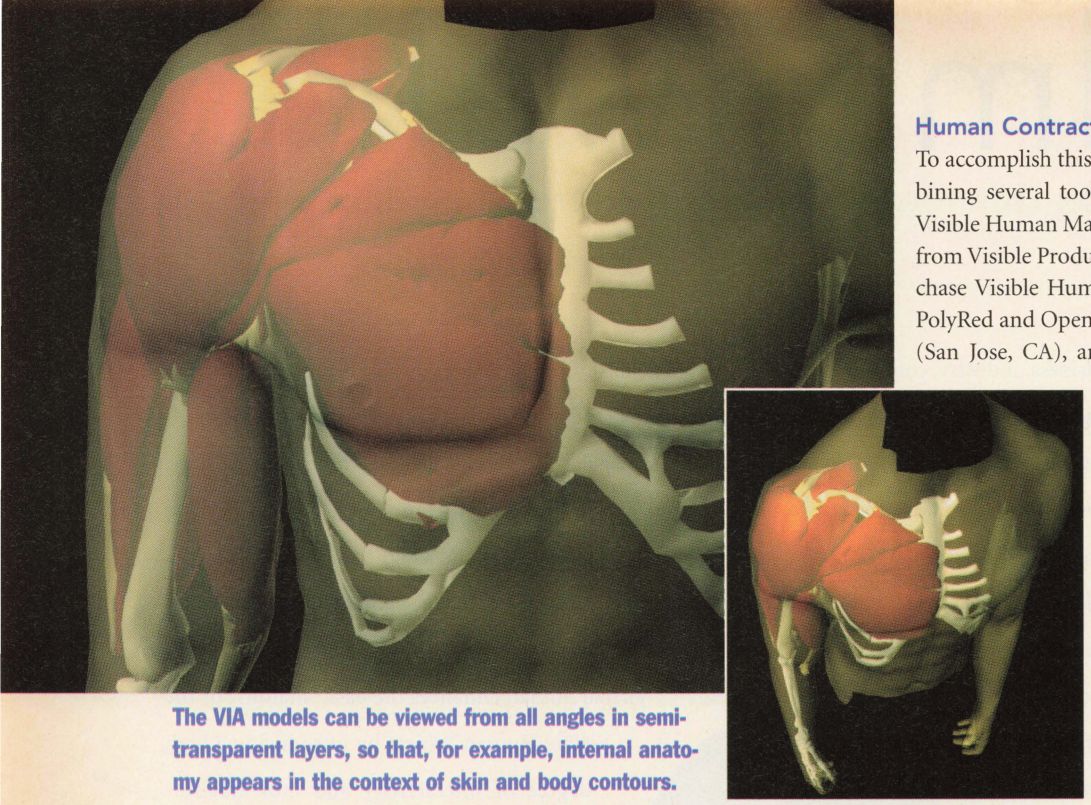
## INNOVATIVE SIMULATION TECHNOLOGY BREATHES LIFE INTO DIGITAL HUMAN MODELS

BY AUDREY DOYLE

Each year, thousands of business, industry, community, and education professionals from the world over flock to NASA's Johnson Space Center in Houston to attend Inspection, a three-day exhibit designed to introduce attendees to NASA-developed space technologies that can be utilized for unique applications on Earth. Usually, attendees find technologies that will help them solve problems in their businesses, or that they can turn into commercial products. But sometimes, NASA finds a company or person with whom to partner on research projects. • Such was the case when Robert Rice attended Inspection96. At that time, Rice was an adjunct professor at the University of Houston and a professor at Montgomery College in Conroe, Texas. He visited Inspection96 hoping to find technology he could use with the recently completed Visible Human Project to develop an interactive, customizable, virtual human body with which to teach his anatomy students. Instead, he found in NASA a partner to help him create such a tool. • That technology—which Rice since developed, with funding from NASA—is called the Virtual Interactive Anatomy (VIA) Project. Available through Rice's company, Dynoverse Corp. (The Woodlands, TX), VIA begins with data from the National Library of Medicine's Visible Human Project. Begun in 1989, the Visible Human Project uses CT, MR, and cryosection images of two cadavers, one male and one female. With these image slices, which were taken at 1mm intervals for the male model and 0.33mm intervals for the female, one can distinguish the internal details of the human body and reconstruct them in 3D with volume rendering. Today, Visible Human data is available either in original form from the government, or as static polygonal or voxel files, from companies such as Visible Productions (Ft. Collins, CO) and Gold Standard Multimedia Inc. (GSM; Tampa FL), that define a segmented structure—for example, the biceps muscle in a person's arm. • Rice's virtual human enhances the basic anatomy of the Visible Human Project by introducing a high degree of interactivity and individualization with the model. Perhaps more significant, it replicates physiology, including blood circulation, muscle fatigue, and joint mobility. As such, it can be used in any application that requires analyzing the human body or a part of the body as it is involved in a process—interacting with an object or an environment, wearing a product, even interacting with a real human. • "I am developing my virtual human at the tissue level," he says, "so that it not only looks and moves like a real human, but can also be used in what-if simulations to analyze how the body reacts when put in positions or situations that can cause stress or harm." Thus, while a Visible Human's biceps muscle, for instance, exists in the form of a static image, a biceps on the virtual human's arm contracts, changes shape when it contracts, responds when a nerve impulse is delivered to it, and becomes inactive if its nerve supply is lost, as in stroke patients. It also fatigues after a period of use, loses mass and force if it's taken into outer space, and ruptures or tears if its tendon is overworked. "All that, and lots



**This Virtual Interactive Anatomy model not only looks realistic, it also replicates human physiology, including blood circulation and muscle fatigue.**



The VIA models can be viewed from all angles in semi-transparent layers, so that, for example, internal anatomy appears in the context of skin and body contours.

### Human Contractions

To accomplish this remarkable feat, Dynoverse is combining several tools. At its base, the technology uses Visible Human Male data, which Dynoverse purchased from Visible Productions and GSM (Rice plans to purchase Visible Human Female data soon). It also uses PolyRed and Open Inventor from MultiGen/Paradigm (San Jose, CA), and SIMM, from MusculoGraphics, Inc. (Evanston, IL). In addition, it can be used with haptic interfaces from SensAble Technologies (Cambridge, MA) for applications requiring tactile interaction. "With these tools, we're taking the Visible Human data and making it come alive," he says.

To simulate a biceps contracting, for instance, Rice first enters into the system variables reflecting a change in the muscle. He manipulates the data using the polygon-reduction tool PolyRed, derives force values and vectors from SIMM, then uses proprietary software to create a model that is fully interactive not just on the surface, but down through the layers of human tissue, from skin to skeleton. The resulting muscle not only looks, but acts like it should. He then renders and adds realistic textures to the imagery using Open Inventor and proprietary software.

more, is what tissue-level properties impart to an otherwise inert object in a computer graphic image of the arm," Rice explains. Dynoverse applies these motions, attributes, responses, and functional qualities to the tissues of the Visible Human model, and turns that model into what is intended to be the most realistic simulation ever created of the entire human body.

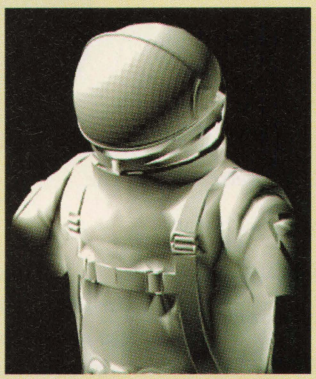
## NASA'S NEW CLOTHES

The qualities and capabilities of the Virtual Interactive Anatomy (VIA) technology make it useful in numerous applications—which Anthony C. Bruins, a systems engineer at the NASA Johnson Space Center, immediately recognized when he first met with Robert Rice back at Inspection96. "We liked his idea, so we asked him to create a proof of concept for us," says Bruins.

Thus, in April 1997, Rice formed the Institute of Somatic Sciences, a non-profit organization at the Houston Advanced Research Center (The Woodlands, TX). That year, he developed a prototype of his virtual model, and at Inspection97 he displayed a virtual shoulder area. The folks at NASA were impressed and approved funding for Rice's work. Shortly afterward, NASA became Dynoverse's first customer, when the agency asked Rice to build an interactive virtual human that NASA could use to help design a new space suit.

Today's space suit was designed primarily to deliver optimal engineering performance, not necessarily to provide comfort for the wearer. "We now want to take a human-centered design approach," says Bruins. "Dr. Rice's technology will enable us to model humans and their movements, then build the suit around them."

NASA is also looking toward future space missions and how a new suit can better accommodate the astronauts. "When we someday explore Mars, for example, we'll need a different suit," says Bruins. Astronauts visiting Mars will be exploring the planet from a geological perspective, which requires a lot of bending, reaching, and kneeling. The existing suit weighs about 275 pounds.; not only is it heavy, it also restricts activity and, therefore, can't support required movements.

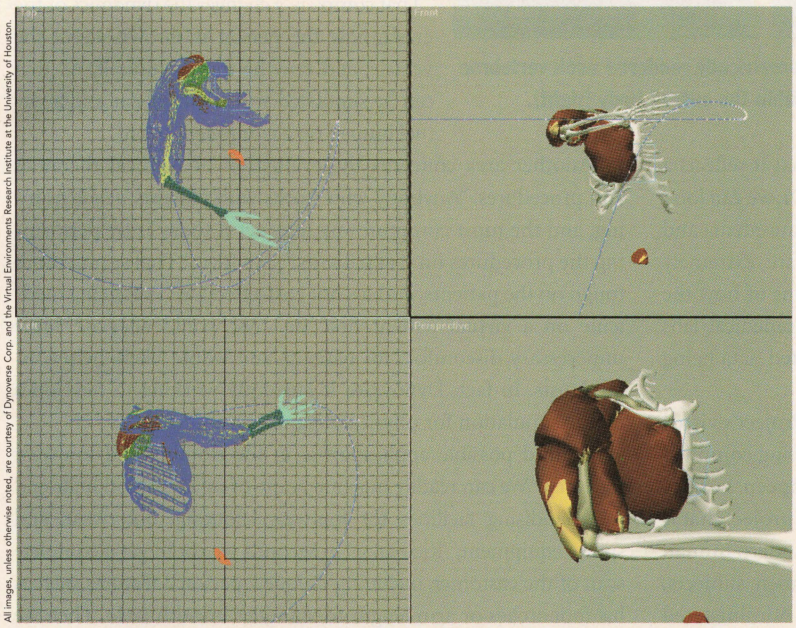


VIA technology is being used to help NASA develop lighter, more flexible space suits that will offer greater freedom of movement to astronauts.

"We'll be able to put the virtual human into the virtual suit and evaluate right there onscreen issues such as safety, performance, comfort, and mobility," Bruins says. If certain areas of the body demonstrate restricted range of motion during simulated tasks, for instance, such results will show up as highlighted areas on the surface of the virtual models. "And because we'll be using virtual-reality technology, we can go through the conceptualization, design, development, and testing phases before we cut any hardware, thus saving time and money," he says.

Currently, the VIA technology is available in two forms: as a product and as a project. In the former case, customers can purchase the human-model source code, along with the rights to further develop and enhance the model and to run their own simulations. "If the user is changing just a few parameters, is not using a highly complex model, or is not working on the entire body at once, we can get this down to a Pentium II PC," Rice claims. Generally, though, the technology requires at least a dual-processor workstation with a recommended 256K of RAM.

However, most customers will license the VIA technology as a project, Rice believes. When customers choose this option, they can feed Dynoverse the data and operational/functional variables relevant to the type of human model (size, shape, age) and the application they want to simulate. Running the technology on SGI workstations, Dynoverse creates, delivers, and implements, in whatever environment the customer selects, a working simulation that has all the appropriate variables and interfaces, haptic or otherwise, that the customer has specified. "We can do this at their site, or we can support it on our servers, and they can access it remotely," he says. "We think most customers will license the technology this way because it gives them exactly what they want, without having to create their own virtual reality simulation infrastructure or buy rights to some of the software subsets we have built into our technology."



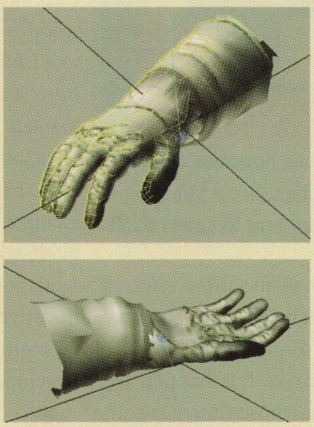
All images, unless otherwise noted, are courtesy of Dynoverse Corp. and the Virtual Environments Research Institute at the University of Houston.

**Each Virtual Interactive Anatomy functional element—bone, muscle, joint—can be seen individually or as a composite from any axis.**

According to Rice, the VIA Project is unique in that it is the only project that will offer such detailed interactive biophysics-based replicas of the entire body. "As a result, we can determine the range of forces that can be generated in a space suit because that's what an astronaut uses to do work," says Bruins. "With Dr. Rice's model, we'll be able to simulate not just how long it will take the astronaut to burst internal components of the glove, but also how long it will take for the hand, wrist, forearm, and shoulder muscles to become fatigued if he performs a certain task—say, turning a wrench for several hours straight—in a certain way."

According to Bruins, after analyzing data compiled by companies that already use virtual prototyping to develop products, NASA anticipates it could slash the time and money involved in creating its new space suit in half. This is significant, especially considering that it typically takes years to bring a suit from the concept to certification stage, a process that in the past has cost millions of dollars.

In addition to a new space suit, NASA also plans to design and build a new glove—one that will enable astronauts to grasp objects and hold them tightly with less fatigue and for a longer period of time. With today's glove, astronauts must learn to work with serious limitations on their hand/wrist motions and comfort. "The glove is an important element of the



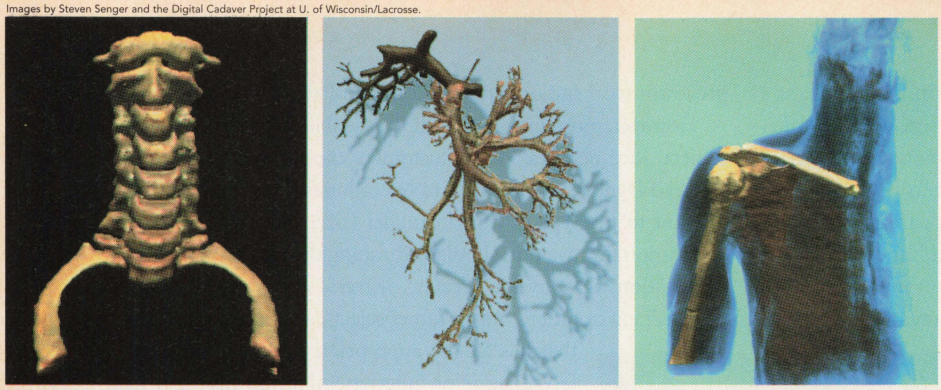
**Object models such as a glove can be displayed as a polygon surface mesh or in texture-mapped format.**

But perhaps the most intriguing application of the VIA technology for NASA—apart from the design of a new space suit and glove—is the simulation of the abnormalities that astronauts suffer due to microgravity or weightlessness. The human body goes through numerous changes when a person leaves Earth's atmosphere. For instance, the heart expands, body fluids pool in the upper part of the body, muscles begin to lose mass and strength, and the bones suffer demineralization. By applying abnormal variables characteristic of these changes to the interactive virtual human, NASA will be able to simulate how these abnormalities affect astronauts during space missions.

"We can apply different levels of stress on the virtual human and study what will happen," says Bruins. Based on such data, the NASA engineers can then develop countermeasures, such as special exercises and diet modifications.

So far, Rice has completed the back, arms, legs, and complete skeleton of the virtual human for the NASA project. " We have enough data to design better gloves and better boots," says Bruins, "and as soon as we get the green light for the next space mission, we'll start using the technology to create some prototypes." In fiscal year 2000, he adds, Dynoverse will begin working on the chest area. "We're slowly building the entire human, piece by piece." —Audrey Doyle

Images by Steven Senger and the Digital Cadaver Project at U. of Wisconsin/Lacrosse.



**Portions of the body can be isolated for viewing, as in the volumetrically rendered neck vertebrae (left) and the internal blood vessels (center), or highlighted within the overall body (right).**

particular muscle, and we can set that range so that it reflects a highly physically trained individual, for instance. Or, we can look at the tissues in terms of hydration level and simulate edema and other vascular changes. Capabilities like these are extremely important in terms of creating accurate simulations of how the body functions." Rice is working with several biomedical labs and research groups to ensure that the tissue-related data being used in the VIA Project is validated.

Another important characteristic of the VIA Project's virtual human model is that it will incorporate data being compiled through CAESAR (Civilian American and European Surface Anthropometry Resource). CAESAR is a research project that is generating 3D data on the size and shape of the modern human body, based on measurements of men and women subjects, ages 18 to 65, in North America and Europe. Administered under the direction of the Society of Automotive Engineers' Cooperative Research Program and scheduled for completion by the middle of next year, the CAESAR survey is the first international anthropometric program to use a whole-body scanner (Cyberware's WB-4) as a data collection tool.

"The Visible Human Project provides images of structures characteristic of only one male and one female cadaver. With the CAESAR data, we can scale our virtual human model so that it is very short and stout, very tall and thin, or anything in between," says Rice.

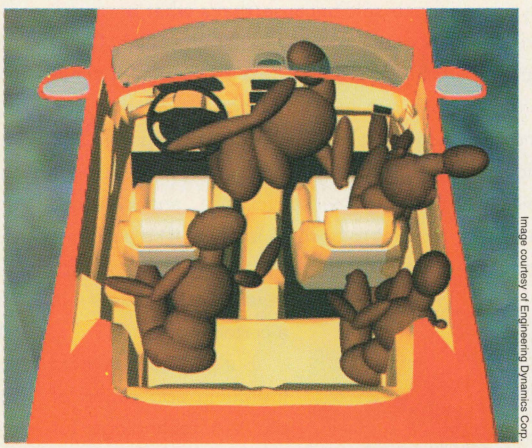


Image courtesy of Engineering Dynamics Corp.

**Conventional crash simulations use dummies without biomechanical response capabilities. But a VIA simulation might, for example, raise an arm to shield itself.**

## Commercial Applications

The capabilities of the VIA technology have far-reaching benefits. Already, NASA is using it to build a better fitting space suit (see "NASA's New Clothes"). However, the technology could be used in any application that involves human safety and comfort.

One of these applications may be vehicle safety testing. In fact, Rice is already investigating the merits of a virtual crash dummy and has written a white paper on it (see www.somaticsciences.org). The crash dummies that are used today, however sophisticated, remain inert. Seated in the test vehicle, they speed down the crash run and smash into the wall, after which they are photographed, and the data their sensors recorded is analyzed. But they will have done nothing in anticipation of the crash.

A virtual model, on the other hand, can replicate avoidance moves prior to the crash. "We can simulate the contraction of the muscles, the raising of the arm to cover the face, whatever someone might really do," says Rice. "That completely changes the dynamics of the crash, how the person is thrown about the vehicle, and how he injures himself. All that can be simulated with a virtual car and a virtual human on a computer screen."

Another area concerns the evaluation of medical therapies and procedures. "Anybody who works with patients needs training, and the most common way they get it today is by performing the procedures on real patients," says Rice. "That's sometimes tough on the patients, and it's not cost-effective." Practicing medicine on a virtual patient first, he says, would alleviate some unnecessary discomfort for patients and would likely help contain costs. In fact, Dynoverse is currently working to develop a haptic simulation for physical diagnosis training.

A third possible application is in the clothing and footwear industry. "We can readily imagine point-of-sale kiosks in high-end merchandising facilities for footwear, clothing, outerwear, and sports equipment," Rice says. "In seconds we could get a complete scan of the customer, including uniquely personal features such as his foot arches or arm length-to-shoulder breadth ratio. Then we could place his virtual counterpart in an appropriate environment and outfit him with virtual clothing, equipment, and shoes, let him try on samples virtually, and make a buying decision without requiring a lot of inventory in the store."

According to Rice, these are not bleeding-edge applications, but rather, applications for which a strong market now exists. All that's needed is the money to fund them. To that end, Rice has been working closely with PricewaterhouseCoopers' (PWC) Intellectual Asset Management Practice to identify companies that might be interested in his technology as well as markets in which the technology may be applicable. Already, according to PWC partner Bryan Benoit, PWC has identified several companies that are interested in the technology, and the firm is "in various stages of negotiations" with them.

The VIA Project is an innovative technology, with far-reaching applications. "It was only a matter of time before all the tools to make this happen were developed," Rice concludes. "It's an idea whose time has come."

*A* Computer Graphics World *contributing editor, freelancer Audrey Doyle is based in Boston. She can be reached at audreyd@mediaone.net.*

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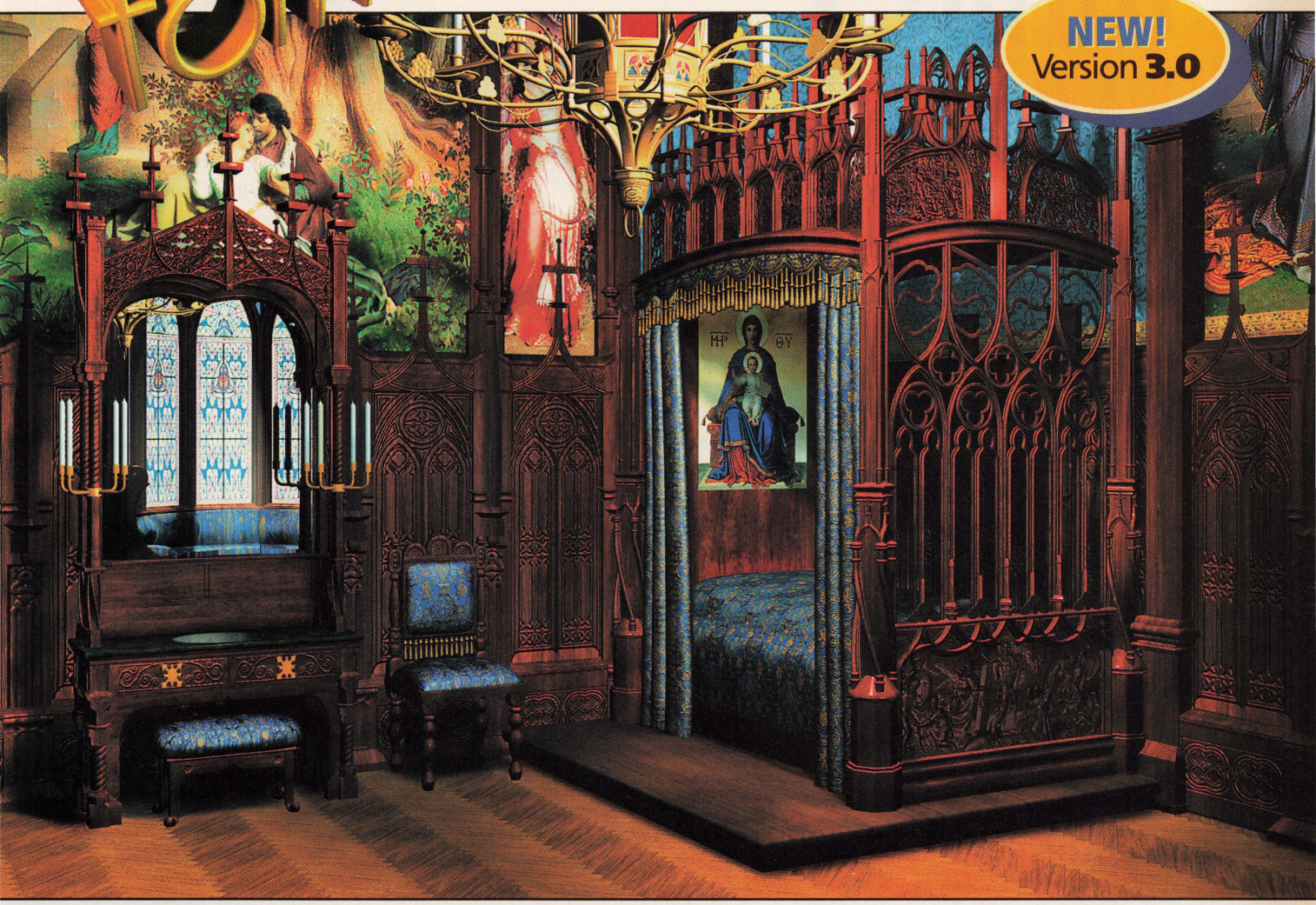

The King's bedroom from the Puzz-3D® CD game *Neuschwanstein: Bavarian Castle* by DYAD Digital Studios Inc., Montréal, Canada. ©1999 DYAD Digital Studios Inc. and Wrebbit Inc.

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# Game WARS

SEGA'S DREAMCAST IS THE NEWLY CROWNED CHAMP OF GAMING CONSOLES, BUT NEW MACHINES FROM SONY AND NINTENDO ARE WAITING IN THE WINGS

BY AUDREY DOYLE

When Sega of America announced its Dreamcast gaming console this past spring, the whole industry was abuzz with excitement. Promising a built-in 56k modem, ultra-realistic 3D graphics at 60 frames per second, and a host of innovative new features, Dreamcast was poised to storm a market that hadn't seen a new-generation console since 1996, when Nintendo of America launched its venerable Nintendo 64.

Dreamcast—which began shipping in September for $199—has lived up to the anticipation surrounding it. Christened the "Product to Watch" in 1999 by *Business Week* and the *Los Angeles Times*, Dreamcast features an advanced 128-bit architecture that Sega says gives it 15 times the power of the Sony PlayStation, 10 times the power of the Nintendo 64, and four times the graphics processing power of the fastest Pentium II processor. Furthermore, Dreamcast is built atop a 200MHz Hitachi SH-4 CPU and utilizes the NEC PowerVR 2DC 3D graphics chip, reportedly the most powerful 3D technology developed to date for a console system.

But while Dreamcast clearly occupies the throne in the kingdom of video-game consoles today, its reign could be short-lived. With the next-generation PlayStation2 game console, scheduled to ship in Japan next spring and in North America next fall, Sony Computer Entertainment is promising a faster CPU and a more advanced graphics chipset than those in Dreamcast. And not far behind Sony is Nintendo of America, which has announced plans to ship by Christmas 2000 its next-generation console, code-named Dolphin, that will reportedly be faster and more powerful than PlayStation2.

Such competition among these three leading console vendors may prove vexing to consumers trying to decide if they should purchase a Dreamcast system now so that they can get state-of-the-art performance today, or if they should hold out to see what Sony and Nintendo have to offer down the road. But for the video-game industry in general, it's great news.

"The video-game market for PCs and consoles was just north of $6 billion in the US and Canada in 1998," reports Edward Williams, senior vice president and research analyst at Gerard Klauer Mattison, a New York City-based firm that has been covering this space for several years. "In fact, in 1999," he maintains, "video-game sales will generate more revenue at the retail level than movies will generate at the box office."

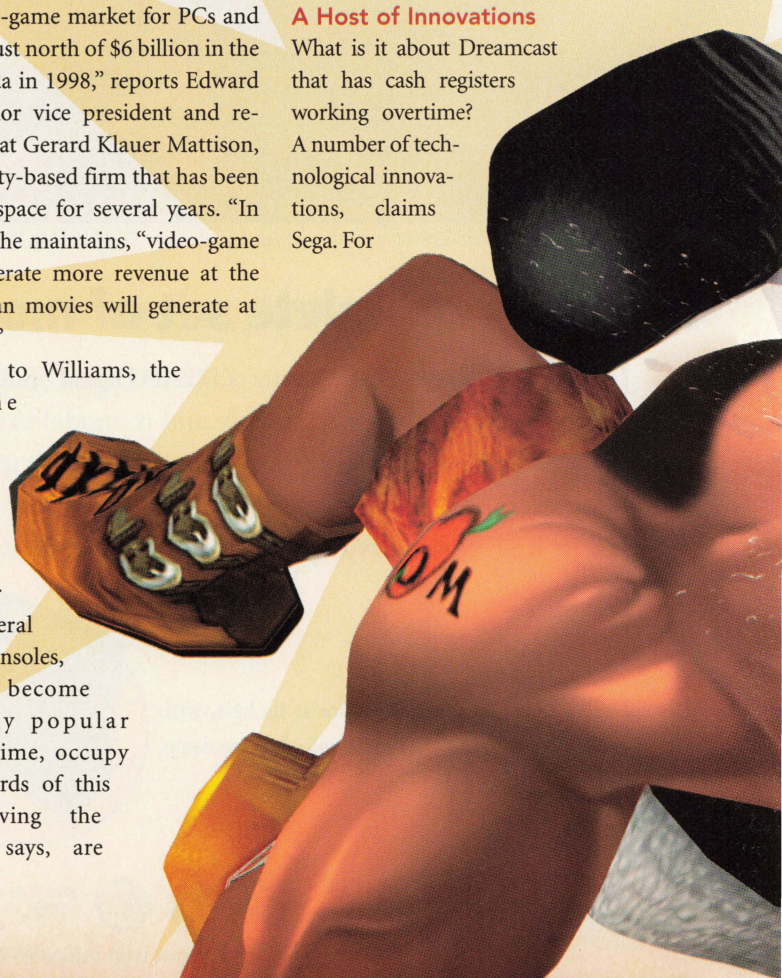
According to Williams, the video-game market has been growing at a healthy 20% to 30% per year for the last several years, and consoles, which have become increasingly popular during that time, occupy about two-thirds of this market. Driving the growth, he says, are sales of PlayStations, Nintendo 64s, and, recently, Dreamcasts.

Indeed, although PlayStation2 and Dolphin may create some tough competition for Sega in the coming months, news of these forthcoming video-game "super-consoles" hasn't thwarted demand for Dreamcast. In the weeks leading up to the system's launch, retailers were logging an average of 2000 presell orders per day for Dreamcast. By the end of August, retailers had presold a whopping 300,000 systems in North America, reportedly shattering the previous North America presell record of 100,000 held by PlayStation, when it debuted here in 1995.

Sales figures since Dreamcast's Sept. 9 launch date are just as astounding. "We were expecting to sell about 400,000 units in the first month, 1 million units by the end of the calendar year, and 1.5 million units by the end of March," reports Charles Bellfield, director of marketing communications for Sega of America (San Francisco). "But in just 13 days we sold 514,000 units in North America alone, and we expect to sell more than 1 million units by Thanksgiving. So we're far surpassing our expectations."

## A Host of Innovations

What is it about Dreamcast that has cash registers working overtime? A number of technological innovations, claims Sega. For



instance, the system's PowerVR 2DC graphics engine boasts a peak performance of more than 3 million polygons per second, providing the fastest, most sophisticated 3D graphics available on a video-game console today. This compares to the current PlayStation performance peak of 360 polygons per second, for instance.

In addition, while the PlayStation and Nintendo 64 have 64-bit processors, Dreamcast is powered by the new Hitachi SH-4 128-bit processor, which provides hardware-based lighting and other special effects, including fog, smoke, translucency, and transparency. The processor also enabled Sega to evolve the system's level of "intelligence," says Bellfield. It provides advanced collision detection, he says, so that computer-generated characters in a football game, for instance, respond and fall based on how they're hit. The system can detect exactly where and how hard the character is hit on the body, and from there it can determine the result—the character may fall, or he may just stumble.

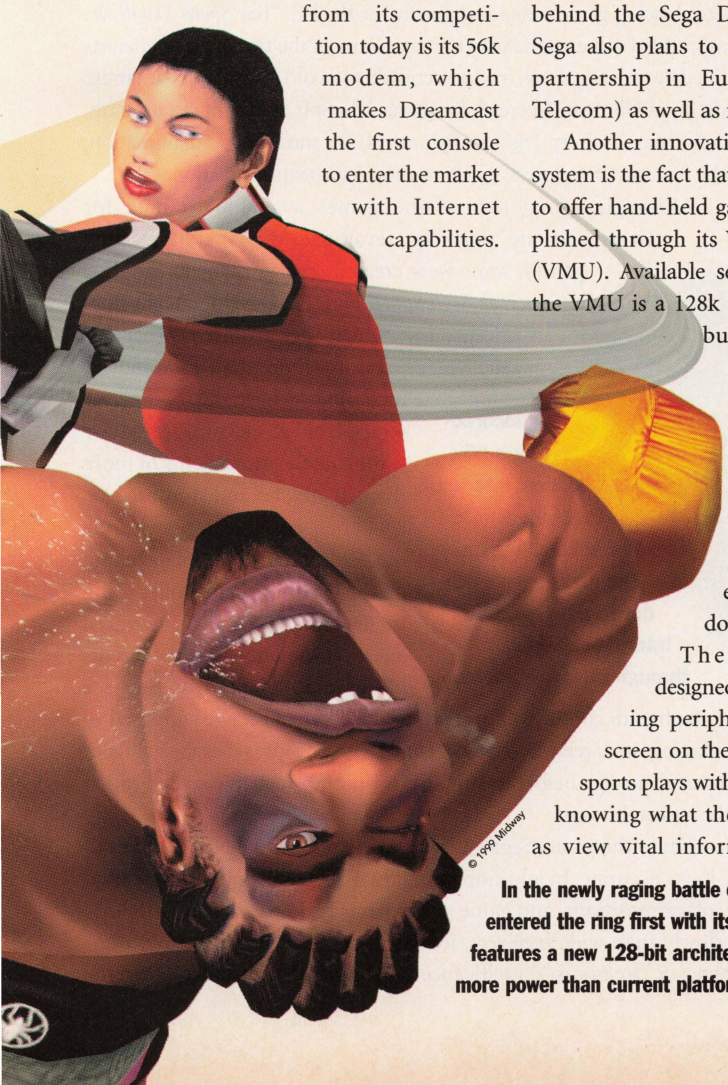
Besides graphics performance, also setting Dreamcast apart from its competition today is its 56k modem, which makes Dreamcast the first console to enter the market with Internet capabilities.

"One of the most important features of next-generation consoles is their Internet capabilities, which will create entirely new uses for the console platform," says Kevin Hause, manager of Consumer Devices research at International Data Corp. (Framingham, MA).

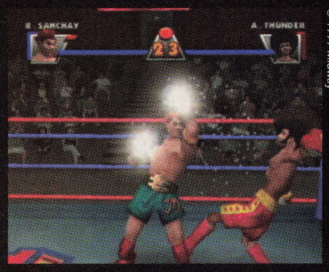
With the modem, users get through their television set full Internet functionality, including chat, e-mail, and browsing. This capability is made available through the Sega Dreamcast Network, an on-line gaming portal accessible through Dreamcast. Also, says Williams, "with Dreamcast's built-in 56k modem, it's now technically feasible to use a console to play on-line games."

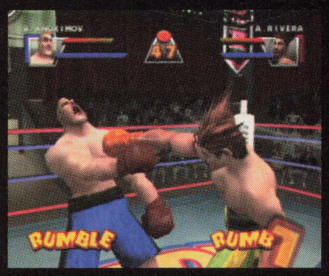
The Sega Dreamcast Network will begin offering real-time networked gaming through several first- and third-party game titles early next year. AT&T WorldNet Service will provide Internet service for Dreamcast, while SegaSoft Networks, creators of the Heat.Net on-line PC gaming community, will provide the technology and infrastructure behind the Sega Dreamcast Network. Sega also plans to establish a network partnership in Europe (with British Telecom) as well as in Japan.

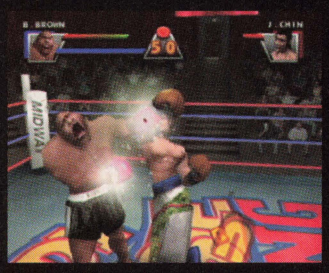
Another innovation in the Dreamcast system is the fact that it is the first console to offer hand-held gaming, a feat accomplished through its Visual Memory Unit (VMU). Available separately for $24.99, the VMU is a 128k memory card with a built-in monochrome LCD screen that plugs into the Dreamcast control pad. When used with the Sega Dreamcast Network, the VMU enables players to download saved games. The device is also designed as a game-enhancing peripheral: Using the LCD screen on the VMU, users can call sports plays without their opponents knowing what they are doing, as well as view vital information that usually



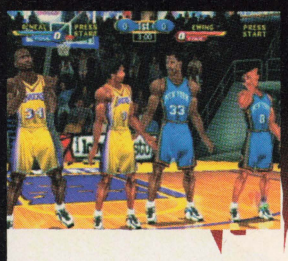
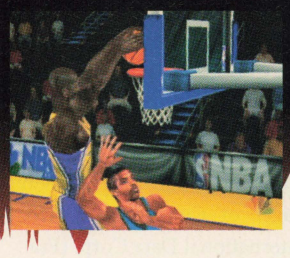
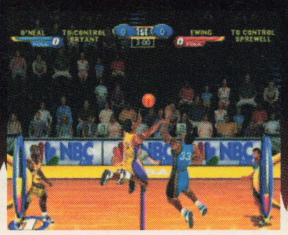
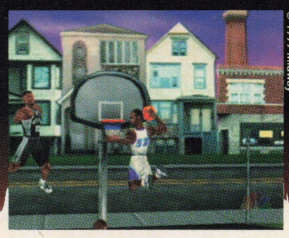

**In the newly raging battle of the consoles, Sega entered the ring first with its Dreamcast, which features a new 128-bit architecture that gives it far more power than current platforms.**



**Published and developed for the Sega Dreamcast by Midway, *Ready 2 Rumble* puts users in the boxing ring. As one of 16 eccentric boxers (each with a unique personality and boxing style), users can clobber opponents with an unlimited number of punch combinations. The game features motion-captured movement and 115 facial expressions that give remarkable detail to the fight, so that when a player lands a left hook, for instance, he or she will see an opponent's face contort with pain and swell with contusions.**





© 1999 Midway

**Dreamcast's development-friendly environment enabled Midway to port over *NBA Showtime* (originally developed as an arcade game) in time for the console's launch.**

appears on the television screen. Some first- and third-party games that utilize the VMU include *Sonic Adventure* (Sega), *Sega Sports NFL 2K* (Sega), *Ready 2 Rumble Boxing* (Midway), and *TrickStyle* (Acclaim).

## Easy Game Development

Although the technological innovations behind Dreamcast are certainly compelling, a game console is virtually useless unless you have games to run on it. "The main thing game developers were asking us to do was to make this machine easy to write games for," says Sega of America's Bellfield.

According to Bellfield, one of the reasons Dreamcast's predecessor, the Sega Saturn, was not a commercial success in the US was the fact that it was a dual-processor system, which developers found very difficult to write for. "When you're dealing with dual processors, you have to write your code specifically with the understanding of what each of those processors is good at," explains Brian Lowe, a producer at Midway Home Entertainment (San Diego), which develops games for the Dreamcast, PlayStation, and Nintendo 64 consoles, among other platforms. "A lot of that code is micro code, in the Assembly programming language. Not a lot of programmers have that ability; they write in C." Launched in 1995, the 32-bit Sega Saturn was discontinued 18 months ago, with only 1.1 million units sold.

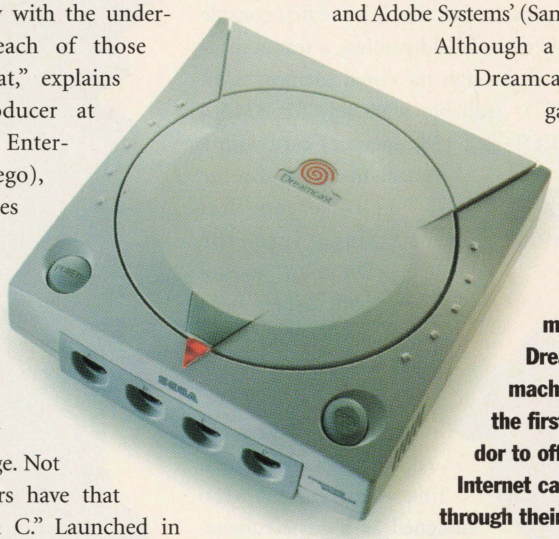
The Dreamcast is far easier to develop games for, says Midway programmer Joe Barnes. "It's a single-processor system, plus Sega has provided good support tools, including compilers and debuggers, as well as very robust code to work with."

"In addition, most game development is done on a high-end PC, and Sega has made it easy to port games over from that development platform to Dreamcast," adds Midway's Lowe. "That makes for a really good game-development environment, which is critical for a manufacturer trying to launch a new game console."

Indeed, having a good set of launch titles is a significant part of a successful console introduction. Although Dreamcast does not ship with any games, 22 titles were available for the console as of the first week of October, for an average price of $39 to $49. And Sega expects between 40 and 50 games to be available for Dreamcast by Christmas.

Some of these games were originally developed for other platforms and ported to Dreamcast. For instance, Midway's *NBA Showtime: NBA on NBC* was developed earlier this year by Midway's Chicago division as an arcade game. Created using a variety of tools, including Alias|Wavefront's (Toronto) PowerAnimator as well as proprietary technology, *NBA Showtime* was animated using an optical motion-capture system. "We captured a performer dribbling and doing behind-the-back moves, slam dunks, and so on," says Lowe. They then used that motion data to drive the movements of the CG characters. In addition to moving realistically, the characters in *NBA Showtime* also look like their real-world counterparts. To accomplish the effect, Midway artists texture-mapped photos of actual NBA players onto the heads of the CG characters.

While some games are straightforward ports, others are revamped versions of existing games developed for other platforms. Ubi Soft Entertainment's (Montreal) *Speed Devils* is based on *Speed Busters*, a racing game created originally for the PC. "For *Speed Devils*, we changed all the textures, added some animations to make some of the tracks more interesting, and further modified the existing seven tracks to create a total of 13," explains Alexandre Thabet, a project manager at Ubi Soft. To create the game, Ubi Soft used proprietary tools, as well as 3D Studio Max 2.5 from Discreet (Montreal) for modeling and animation, and Adobe Systems' (San Jose, CA) Photoshop 5 for texture creation.



**By incorporating a 56k modem into the Dreamcast machine, Sega is the first console vendor to offer users full Internet capabilities through their televisions.**

Although a majority of the games available to date for Dreamcast are ports or revamped versions of existing games, some were created expressly for Dreamcast, such as *Sega Sports NFL 2K*. Developed by Visual Concepts, Inc., which Sega acquired earlier this year, *NFL 2K* features more than 1500 moves, including tackles and two-player wrap tackles, accomplished by capturing the movements of more than 20 athletes and stuntmen.

Other novel features include on-field play calling, play calling on the Dreamcast controller using the Dreamcast VMU, 12 hours of audio commentary, and incredible graphic detail. "You can see the breath coming out of players' noses when they're supposed to be playing in Green Bay on a cold day," enthuses Sega's Bellfield. Consoles weren't powerful enough before to support techniques such as fogging, which was used to create this effect, he says.

To add further realism to the game, Sega enlisted the help of actual NFL coaches to make sure each play looks accurate. In addition, individual 3D player models were used to differentiate NFL player positions, and game play reflects real-life physics, with linemen moving more slowly than wide receivers, for instance. The game is further optimized to take advantage of Dreamcast's intelligence capabilities. For instance, when the

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**After some revisions and enhancements to its PC-based *Speed Busters* racing game, Ubi Soft recently released the title as *Speed Devils* for the Dreamcast.**

game player tackles the tight end, the character doesn't just fall over. He responds to the direction and force of the tackle, and even stumbles if the game player's aim falls short. Also, the game creates a new game-play situation on every play, so if the player tries to run the same play repeatedly, the system will learn his moves and use them to beat him.

## Strong Competition

While it's clear that Dreamcast is the current leader in the video-game console arena, both Sony and Nintendo are feverishly working to develop next-generation systems whose features will reportedly surpass those of Dreamcast.

Although Sony has been tight-lipped about its PlayStation2, the company has divulged some information. For instance, the system is scheduled to launch in Japan on March 4, 2000, for a price of 39,800 yen (about $375) and in North America sometime next fall (the US price was unavailable at press time). The PlayStation2 hardware package will include the PlayStation2 computer entertainment system, as well as a new Dual Shock2 analog controller boasting a storage capacity of 8MB of data and a data transfer rate up to 250 times faster than PlayStation's current memory card. "In addition, the PlayStation2 will support both the audio CD and DVD video formats, and the hardware has a CD-ROM and DVD-ROM drive," says Kaz Hirai, Sony president and chief operating officer.

Sony adds that the PlayStation2's performance will come from a unique, Sony-developed architecture based on a number of custom chips. For instance, the console's CPU, which runs at nearly 300MHz, is based on Sony's 128-bit Emotion Engine chip, which incorporates two 64-bit integer units with a 128-bit SIMD multimedia command unit, two independent floating-point vector calculation units, an MPEG 2 decoder circuit, and high-performance DMA controllers. According to Sony, the combined performance of the CPU will permit complicated physical calculations, NURBS curved-surface generation, and 3D geometric transformations that are difficult to perform in real time, even with high-speed PC CPUs. "The combined processing performance of our Emotion Engine chip exceeds 6.2 billion floating-point operations," states Phil Harrison, vice president of research and development and third-party relations at Sony.

Additional system specs include 32MB of direct RAMBUS DRAM, "the fastest available in the market today," according to Harrison, and an impressive new graphics chip called the Graphics Synthesizer. Interestingly, it's rumored that PlayStation2 will be a dual-processor system; however, Sony has not provided data to substantiate that information.

## Great Expectations

Needless to say, the details Sony has revealed have people talking. "I've seen a demonstration of the PlayStation2, and it's definitely an extremely impressive machine," comments Gerard Klauer Mattison's Williams. "From what I've seen, the PlayStation2 will have better graphics than Dreamcast." What's more, he says, Sony has revealed that the PlayStation2 will be backward compatible with the original PlayStation console, thus legitimizing consumers' investment in their existing PlayStation software libraries. Dreamcast, on the other hand, is not backward compatible with past Sega consoles. "So, theoretically, PlayStation2 will launch with a library in excess of 600 titles," Williams says. However, those titles will run exactly the way they do on the current PlayStation, so players won't see a difference in terms of graphics or speed.

Although Sony could not state definitively how many new titles will be available at launch, the company did say that it is aware that more than 128 titles were in development as of October. Along those lines, it also released information on its new software development tool kit, claiming that it offers several significant improvements over the development environment for the original PlayStation.

For instance, the original PlayStation tools were supplied in the form of a PC extension board that required a PC or workstation. Connecting the PC or workstation to a network added further complexity to the development process. In contrast, the PlayStation2 development tools combine two separate operational modes in one unit: regular PlayStation programming/debugging mode and a new workstation mode. In the new mode, the tools can be used as a Linux-based workstation, enabling developers to create graphics in the PlayStation2 development environment that were previously possible only on a separate workstation. When the development tools are employed with an Ethernet network connection, the result is reportedly a seamless development environment. According to Harrison, Sony has begun delivering development systems to third-party software development partners in North America.

Sega's Dreamcast will also face some tough competition from Nintendo, which has announced plans to ship its new Dolphin system for the holiday 2000 season. Because it does not plan to ship product for at least another year, Nintendo isn't releasing many details. However, the company did claim that Dolphin, which will also be a 128-bit system, will feature a graphics chip that will far exceed the capabilities of the PlayStation2. ArtX (Palo Alto,

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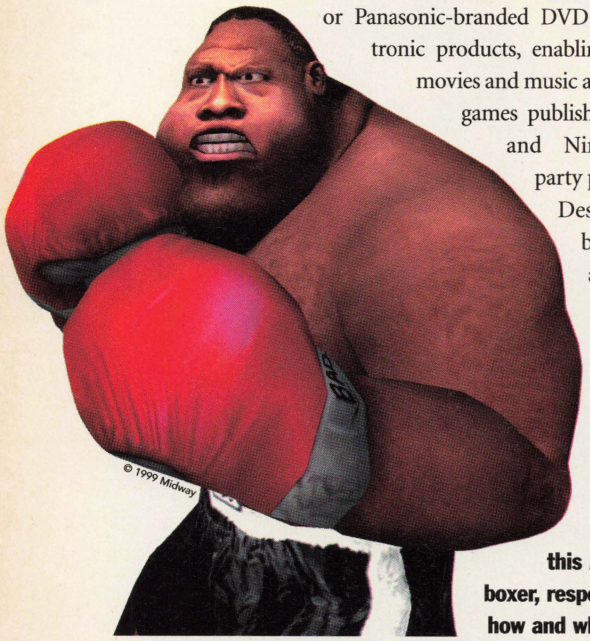
CA), a company headed up by Dr. Wei Yen, who is primarily responsible for the Nintendo 64 graphics chip, is developing the new chip.

Dolphin will be powered by a 400MHz CPU based on a processor called Gekko, being developed by IBM. Also, Matsushita will develop, manufacture, and supply Nintendo with a DVD disk drive for incorporation into the Dolphin hardware unit (the software medium will be DVD, manufactured by Matsushita). In addition, Dolphin's technology will be integrated into various Matsushita- or Panasonic-branded DVD consumer electronic products, enabling users to play movies and music as well as Dolphin games published by Nintendo and Nintendo's third-party publishers.

Despite the rumblings Sony and Nintendo have been making regarding the superior power and graphics of their next-generation systems, Sega's Dreamcast is nonetheless an impressive machine. "Dreamcast is far superior to anything that's out there now, and I think it will sell extremely well," comments Williams.

Exactly how well is difficult to say. But the moment of truth may come as early as March. As a general rule of thumb, Williams says, a console must achieve an installed base of 8 million units in North America within 18 to 24 months from launch if it is to be a viable platform for developers to publish games on. "If PlayStation2 has an extremely successful launch in Japan in March, publishers may start allocating their resources to that platform instead of to Dreamcast," he says. Without new and compelling content, it may be difficult for Dreamcast's installed base to reach 8 million in that timeframe, he adds. At press time, Electronic Arts—arguably the industry's largest game developer—still had not announced support for Dreamcast. (Currently, EA supports the PlayStation and Nintendo 64.)

Analyst predictions aside, Dreamcast is the state-of-the-art today in terms of game consoles. The multifunctional machine is more powerful than any game console ever created, the graphics are rich and realistic, and at $199 the price is surprisingly affordable. As such, Dreamcast will more than likely put a smile on the faces of hundreds of thousands of avid gamers this holiday season.




**The Dreamcast processor provides advanced collision detection, so CG characters, like this *Ready 2 Rumble* boxer, respond based on how and where they're hit.**

*Freelancer Audrey Doyle is a* Computer Graphics World *contributing editor and former editor-in-chief of* Digital Magic. *Based in Boston, she can be reached at audreyd@mediaone.net.*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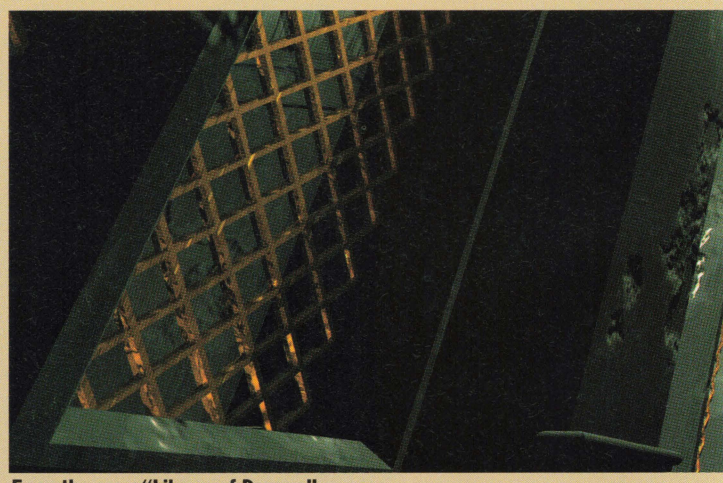
From the song "Chant of Hope"

From the song "Oasis"



From the song "Library of Dreams"

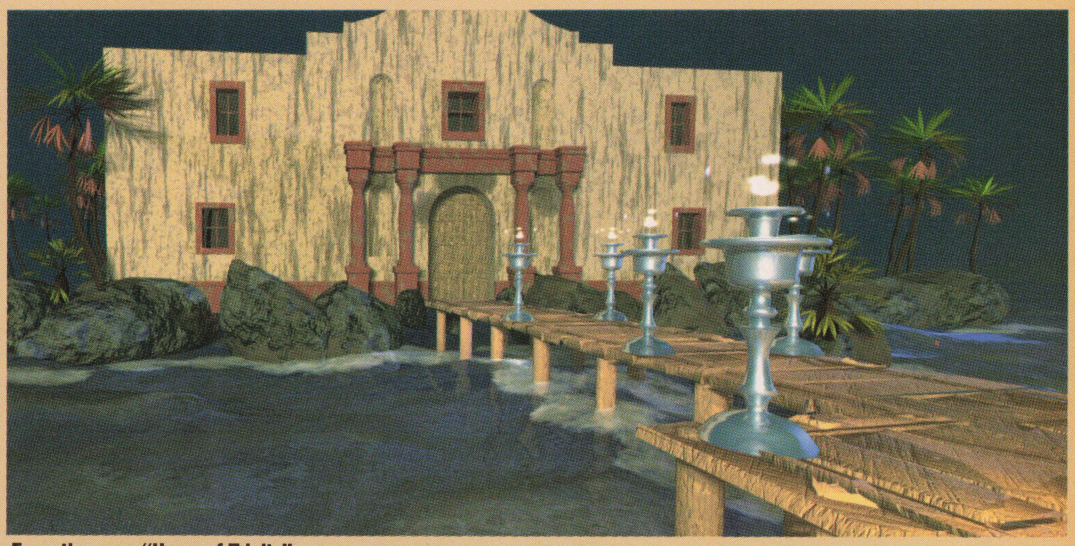
# The Fantasy World of Aura-Luna

Sebastian Dosch is a moody person. As owner of software developer Dosch Design (Marktheidenfeld, Germany), he has helped countless 3D artists establish a mood for their art through the use of his company's DirtyUp program. More recently, Dosch is tapping into the emotions of a more diverse audience by blending his visual artistry with a selection of mystical sounds from a wide selection of international musicians. This sensory combination, he says, will transport listeners to *Aura-Luna*, a collection of fantasy worlds "filled with emotion and immense atmosphere."

The *Aura-Luna* project, produced by Dosch and published by Sony Music, contains a CD of musical scores composed and arranged by Rupert Schellenberger. To help establish a visual context for the songs, Dosch created a booklet of 3D imagery that accompanies the music "to help your imagination travel into the worlds of *Aura-Luna*," a name that, like the project itself, evolved from the creator's mind.

"I always wanted to create a place where the listener is able to escape and relax," Dosch says. "To support this, I didn't just create images; I created visual worlds." To design the 14 locations of *Aura-Luna*—one for each song on the CD—Dosch used NewTek's (San Antonio, TX) Lightwave and his company's own DoschTextures, DirtyUp, and Aqua-Pack Lightwave plug-ins. A selection of images from a few of these worlds is displayed on the following pages.

The *Aura-Luna* CD is currently available in Germany and will be released in the US during the spring of 2000. Additional information about the project is available through Dosch Design at www.doschdesign.de. —*Karen Moltenbrey*



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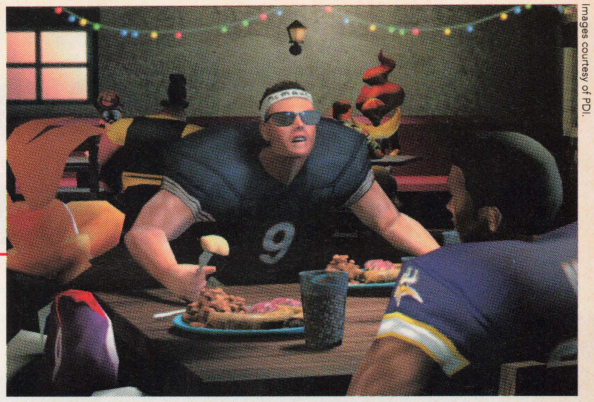
BROADCAST

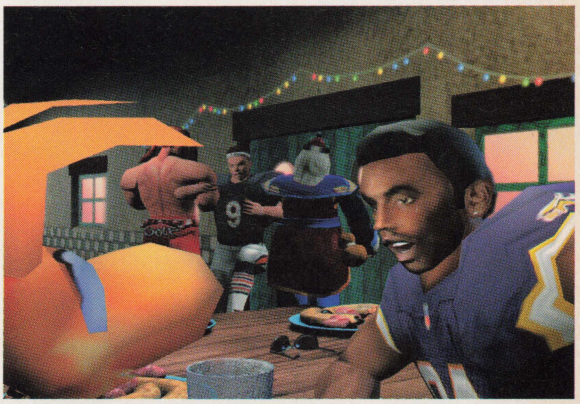
# OUT-OF-GAME EXPERIENCE

## PDI recasts game characters for Sega commercials

BY KAREN MOLTENBREY



Images courtesy of PDI.



**In the "Old Days" broadcast commercial for the Sega Dreamcast, former quarterback Jim McMahon rants to Randy Moss about his Sega Genesis days. To achieve his Dreamcast-quality appearance for the spot, PDI animators gave him a face-lift, wrapping photo textures around the head of a generic player from the newly released *NFL 2K* game.**

For veteran animators at Pacific Data Images (PDI), creating a series of television commercials heralding the rollout of the Sega Dreamcast gaming console required some uncharacteristic moves. Not only did they recast previously created game characters for the spots, but they also created new backgrounds and environments that made the characters seem right at home.

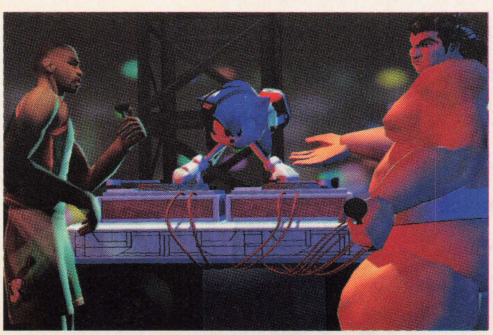
Using actual game models from Sega and third-party developers, the artists created seven computer-animated commercials that feature dozens of 3D characters from popular video-game titles that interact seamlessly with one another. "You've never seen so many different characters from so many different game companies together in one place. It's hard to imagine *Sonic Adventure*'s hedgehog running past *The House of the Dead 2*'s zombie, or *NBA 2K*'s Allen Iverson seeking advice from *Virtual Fighter 3*'s Taka," says Curt Stewart, lead technical director.

To depict Sega's "In the Box" ad campaign—whose concept is that everything occurs within the Dreamcast machine—the PDI animators created a virtual world where the game characters live, work, and help one another master their skills so they can outmaneuver and outthink their human opponents. This supports Sega's tag line of "It's Thinking," which refers to the artificial intelligence that enables the game-engine technology to respond to and "outsmart" the player. (For details about the game console, see "Game Wars," pg. 46.) However, inserting the third-party characters and game environments into a whole new world required quite a bit of ingenuity by PDI.

According to PDI producer Denise Minter, the technical challenge was to retain the various game assets in their original format while blending them with the CG elements created by PDI. "Usually for spots like these, they will show about two seconds of game footage, whereas we used the actual characters and textures right from the games, not from the [introductory] full-motion videos. That's how good these models are. They really hold up, even for close-ups, and they're extremely detailed—down to the players' tattoos, facial hair, and cornrows," she says. "It's a real breakthrough."

### Game Converts

The first step in the process was acquiring the characters and environments from third-party developers, which proved difficult. Since PDI was under a nondisclosure agreement, the team could not fully explain why the models were needed. Finally, after a lot of assurances that the imagery would not be altered, the animators began receiving the assets. In all, 55 characters and a handful of environments from several games made their television debut.



**Using its proprietary tool set, PDI combined 3D characters from a variety of games, including *NBA 2K*, *Virtual Fighter*, and *Sonic Adventure*, into the "Daydream" TV commercial.**

Because PDI used a proprietary animation tool set, the first step (which consumed half of the 12-week production period) required the research and development team to script code so the game characters could be pulled out of their native formats—such as Alias|Wavefront's (Toronto) PowerAnimator, Avid's (Montreal) Softimage, and Discreet's (Montreal) 3D Studio Max—and converted into the PDI tool set.

"The critical part of the conversion process was maintaining the look and movement of the characters," notes Stewart. "When you work with finished elements that are not your own, they already have an established style that shouldn't be changed. This made it more challenging to blend some of the characters into our own or the other developers' environments."

To model the environments created at PDI, the group predominantly used PowerAnimator, Softimage, and Alias|Wavefront's Maya, while the remaining processes were completed with in-

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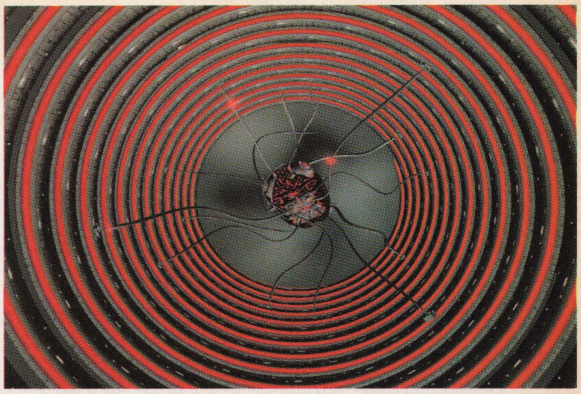


The artists inserted full 3D game models and environments into the PDI-created spiral sequence at the beginning of the "Opening Day" commercial, even though close views of the game images appear for only seconds.

house tools, all running on SGI (Mountain View, CA) O2s on the desktop. For some of the commercials that required compositing live-action footage into the CG, a proprietary in-house system was used for the basic shots, while Maya Composer and Discreet's Flame were employed when more extensive compositing was required.

For some spots, the group had to provide lip sync to game characters that don't normally speak. To accomplish this, the PDI artists remodeled the characters' mouth shapes and used a simplified facial-blending system that was developed in-house. In "Old Days," a CG Jim McMahon, former Chicago Bears quarterback, rants to a CG Randy Moss of the Minnesota Vikings about the privileges of appearing in a Dreamcast game compared to his Sega Genesis days during the 1980s.

Because McMahon is not on the current game roster, the animators used a generic player from *NFL 2K* as a base model, and added textures from the game to create the Bears uniform. To make the generic player look like the colorful McMahon, Minter took digital pictures of the former player during the voice-over recording. The animators then wrapped those textures around the head model and added facial targets for the eye blinks and lip sync. Appearing in the background of the spot are several other game characters and NFL stars interacting at a PDI-created cantina.

In the "Opening Day" commercial, crowd control became a major issue, as the animation team converted more than 40 different game characters into PDI's software format.

Key to matching up all this different 3D imagery, says Minter, was creating the same type of imagery and lighting in the commercial that was used in the games. "We had a limit as to how far we could push the CG because everything had to look as though it belongs together," she explains. To achieve this continuity, the group chose as its highest order of graphic reference the game *Shenmue*, which features extremely organic imagery and moody, mysterious lighting, as opposed to plastic-like imagery and unnatural lighting. "We reviewed [the game] and said, that's how far we can push our lighting, motion blur, and facial animation," she notes. "But to nail the lighting so we could match a move or a look and translate that into another medium took a lot of work and a lot of lighting passes."

## A Crowd-Pleaser

Often, size and scope became issues for the PDI artists, as two of the spots contained more than 40 of the 55 game "converts" and environments. "Most of the time, the job was really about size— we weren't talking about just bringing in one or two characters at a time," Stewart says.

For instance, in the beginning of the "Opening Day" spot, viewers experience a wild fall through the CG Sega spiral, where they pass by several game environments, plus a few created by PDI (such as the cantina background from "Old Days"), layered atop one another. This segment involved so much imagery, according to Minter, that if all the objects had been built to scale in the real world, the spiral would have been about two miles deep. But even so, the group did not cut corners, and instead used the full game models for the appropriate layers. "Even though you may only see each level for about five frames, if someone were to review it in slow motion," she says, "it would all be there."

With two of the commercials containing at least 40 characters, PDI also had to focus on crowd control, something the group mastered for its 1998 all-CG feature film *Antz*. To speed the rendering process for all the geometry, an artist wrote a crowd system for PDI's proprietary renderer that lowered the resolution of models as they moved farther from the camera. "At one point, there were almost 2 million polygons floating around," Stewart says.

Nevertheless, some frames required about two hours to render in PDI's render-farm of SGI Origins, although the goal was to keep each frame at less than one hour. "We understand that when you have hundreds of models in a crowd scene, your render times are going to be longer. So you try to be as economical as possible by hitting that shot as early as you can," Stewart says. "A few years ago, our renderer may not have handled millions of polygons, but today it can. Everything in general has gotten faster," which is how a commercial project of this caliber can be done.

In fact, Stewart likens the production process for the "In the Box" series to what is required for feature films—the only difference being length. To produce the 90 seconds of animation for the first three spots required a core team of about 40 animators and other professionals. "It was like working on a mini *Antz*, given the large number of unique characters," he says.

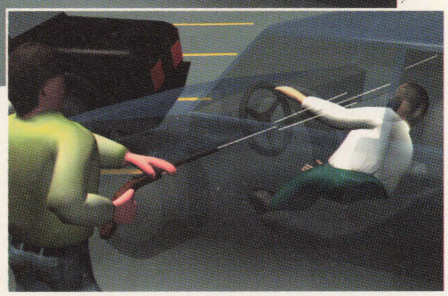
**Key Tool** **PDI's** proprietary tool set (www.pdi.com) **infoNOW 80**

SIMULATION

# FORENSIC ANIMATION

## Mexican officials use digital technology to re-examine evidence in a political assassination

BY KAREN MOLTENBREY



Images courtesy of Digital Shop.

**Mexican officials hired animators to re-create their official case file on the 1993 assassination of Cardinal Posadas, the archbishop of Guadalajara. The police are hoping that the simulation, which will be aired on national television in Mexico, will finally lay to rest years of public and political dispute concerning the murder.**

More than six years have passed since Juan Jesus Posadas Ocampo, a cardinal in the Catholic Church, was killed during a shoot-out by drug cartel members at the Guadalajara international airport in Jalisco, Mexico. Since then, rumors and theories about the incident and the priest's possible involvement with Mexican drug lords have persisted, mainly because the facts of the case—labeled a political assassination by the Mexican government—have never been released to the public. But now a 3D simulation of the event, sanctioned and used by government officials to aid in their investigation, will be broadcast on Mexican national television.

"There has been a lot of speculation long after the cardinal's assassination over whether his death was a result of his involvement with drug dealers or if he was just in the wrong place at the wrong time," says animator Fernando Gonzalez, owner of Digital Shop, the small animation boutique in Mexico City that created the 70-second simulation.

This debate has not been limited to the public arena. There has also been reported disagreement over the facts of the case among the Catholic Church, the Jalisco State Government, and the Procuraduria General de la Republica (PGR), the Mexican counterpart to the FBI in the US. Were the cardinal and several other bystanders killed accidentally in a fusillade of AK-47 rifle fire during an unsuccessful "hit" on reputed drug lord Joaquin (Chapo) Guzman by a rival leader as he arrived at the airport? Or was the cardinal the intended target because of an alleged relationship with one of the crime leaders or because he possessed information linking government officials to drug activity?

In an attempt to help the investigators better sort out the facts and possibly reach an official agreement, forensic criminologist Epifanio Salazar, head of the PGR's Caso Posadas special investigative unit, hired Digital Shop to re-create the shooting using computer graphics. After months of political and public pressure, the PGR has agreed to release the simulation, and its findings, to the national media in Mexico so the public can "view" the facts for themselves.

Creating what is believed to be Mexico's first forensic animation required the same type of accuracy the police officials used during their investigation of the initial crime scene. "Everything in the simulation had to be exactly as it was on that day," Gonzalez says. Every person and object had to be modeled to the exact size, scale, and location, and each bullet had to follow a specific path in order for the action to unfold as it actually occurred. If a vehicle were to be placed one meter too far to the left, for instance, it could have affected the entire scenario by blocking a victim.

To ensure that the 3D version depicted the actual events, the PGR provided Digital Shop with boxes of its top-secret investigative files—including thousands of photographs, numerous eyewitness testimonies, measurements, autopsy reports, and laser-beam studies of the bullet trajectories. Also included were detailed diagrams by law-enforcement officials showing the exact positions of the victims and the shooters, as well as the bullet paths.

### Creating a Scene

Since the entire scenario unfolded at the airport, the first modeling task for the four-person Digital Shop team was to replicate the building and its surroundings. To achieve the exact scale of the airport, Gonzalez used the 2D architectural plans of the structure as a guideline for his 3D model, which he produced with NewTek's (San Antonio, TX) Lightwave on an Intergraph (Huntsville, AL) TDZ 600 workstation. "They even wanted us to include the bricks in the entranceway to the airport," he says, which were built with Enzyme Studios' (Auckland, New Zealand) procedural shaders.

The next CG hurdle was to hand-model the 1000 vehicles appearing in the crime-scene photographs. To speed the process, the artists made simplistic, boxy models for the vehicles in the far background, and built more complex versions—completely textured and shadowed—only for those close to the action.

Because many of those believed to have been involved in the shoot-out were killed or later arrested (some on unrelated charges), the investigators were able to provide the animators with descriptions of the characters, which were modeled in Lightwave. While each character's height and weight were important to the re-creation,

the simulation didn't require the artists to clone the individuals' actual faces. Instead, they painted and mapped generic facial textures using Adobe Systems' (San Jose, CA) Photoshop, and used Metacreations' (Carpinteria, CA) Painter 5, NewTek's Aura, and a variety of shaders for the other character and object textures.

The most challenging part of the project involved the character animation. "We animated about 20 characters performing specific actions in eight different scenes, and the dynamics of all that movement had to be right on," Gonzalez notes. "It would have been easier to do this in Maya or another package, but the necessary tools were not available here at the time," he says. Instead, animator Jose Kuri used Fori Owurowa's Puppet Master (Virtual Reality Pictures; New York), a Lightwave plug-in that "slices" models into a number of pieces that are animated through inverse kinematics to achieve independent movement. He then used Metamation, another Lightwave plug-in, to convert the low-resolution models to high-resolution versions for the simulation.

**Because the simulation was used as an investigative tool, the artists had to follow exact specifications for modeling and placing the images.**

Even the bullets were represented graphically, using single-line polygons with a clip sequence map painted in Aura to achieve a moving "dotted" line from the guns to the points of impact. To simulate the blood particles, the group used NewTek's HyperVoxels technology.

Using Lightwave's Screamernet, the group spent about 80 hours rendering the 2000 frames on a renderfarm of Intergraph workstations and Pentium PCs running Windows NT. The final cut, which contains more than 260 3D objects with a polygonal count of about 263,000, was edited on a Speed Razor non-linear editing suite from in:sync (Bethesda, MD).

The digital re-creation proved to be a valuable investigative tool. Prior to contacting Digital Shop, the PGR had attempted to re-enact the crime scene using physical models that moved on wires, "but it looked horrible, and things didn't move accurately," Gonzalez says.

However, using computer graphics enabled the PGR investigators to get up close to the action for each shooting, then watch the entire scene unfold from a bird's-eye view, a unique perspective that could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Screenshot from a real-time simulation in Opticore Opus Studio™. CAD data courtesy of Volvo Cars.

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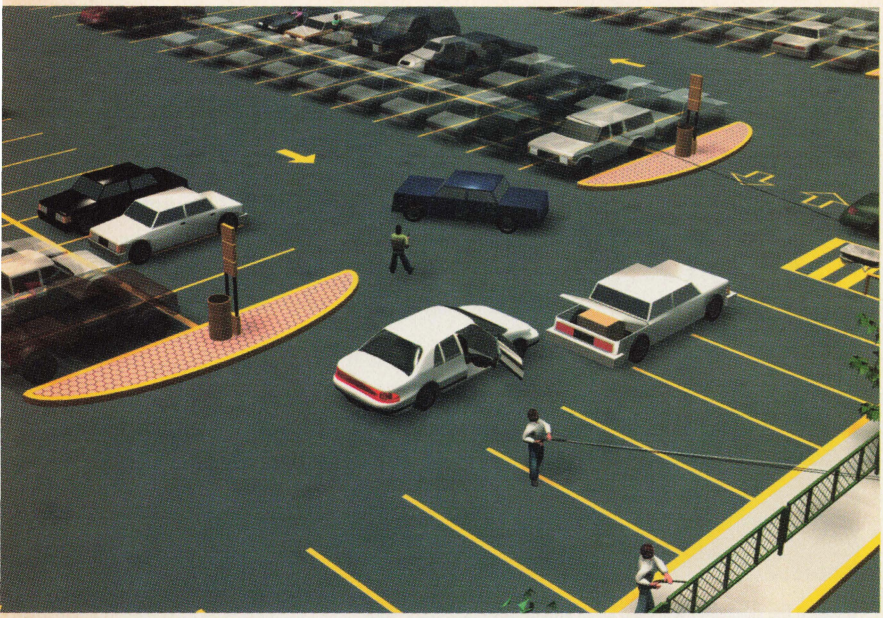

Using NewTek's Lightwave, the animators hand-modeled more than 1000 vehicles appearing in the crime-scene photographs, adding more details to those closer to the camera.

not be achieved any other way. "They were able to see everything occur right before their eyes, which was their main objective for making the simulation. They could even zoom in about three meters from the person who shot the cardinal," he adds. "The simulation did everything they wanted it to do."

## An Open and Shut Case

Since the PGR had not publicly commented on the evidence as of press time, it is unknown whether the simulation unveiled any startling new information. And whether or not the animation will finally end the speculation and bring a definitive close to the case is still anyone's guess, as no plans were announced as of press time for the federal, state, and church officials to collectively review and discuss the visualization.

An earlier attempt to resolve the issue occurred a year ago, when an Inter-Institutional Commission comprising Jalisco officials and the Guadalajara archdiocese reviewed the evidence. While that investigation spawned a series of related events, including dozens of criminal charges, it failed to result in a consensus concerning a motive, with reports claiming that the government believes the cardinal was killed by mistake, while the cardinal's successor has been quoted as rejecting that theory. He maintains that Posadas was killed deliberately because he possessed sensitive information concerning government officials' involvement in the drug trade. As of press time, the simulation had not been publicly released, and the special investigative unit assigned to this case was still active.

**Key Tool** **Lightwave**, NewTek (www.newtek.com) infoNOW 81

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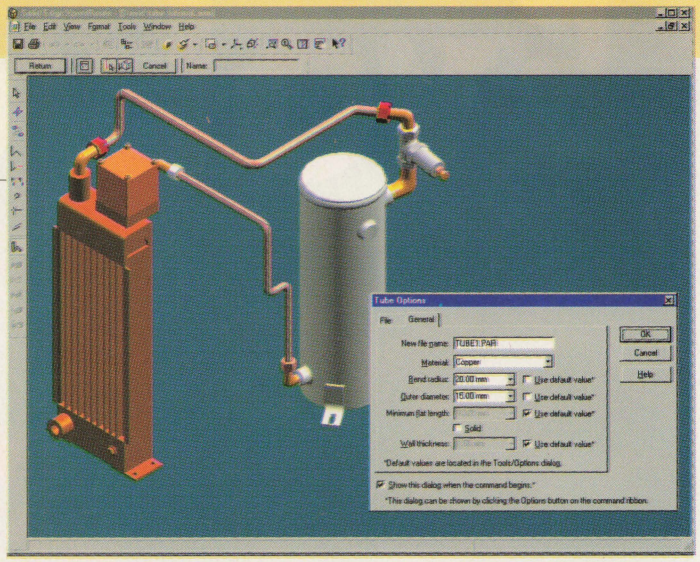
# Solid Edge 7

## New tubing design module heads list of enhancements

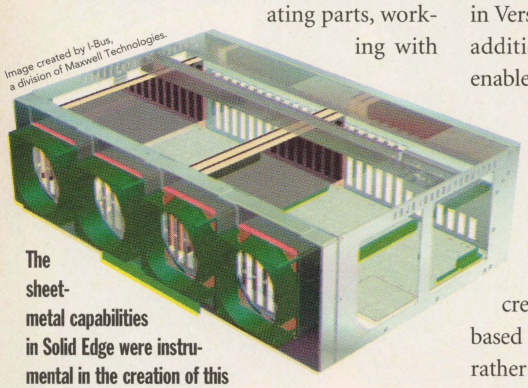
BY DAVID COHN



The new XpresRoute module makes it easy to define 3D tube paths, specify parameters, and create tubes that are fully associative to the parts with which they connect.

Solid Edge Version 7, the latest release of Unigraphics Solutions' mid-range mechanical modeling package, boasts 250 new features and enhancements, the most notable of which are a tubing design module, new plastics and sheet-metal design capabilities, an automatic feature recognizer, and additional improvements for creating assemblies and drafting.

As in previous versions, Solid Edge is divided into separate environments for creating parts, working with sheet metal, constructing assemblies, and producing drawings. Each environment is self-contained and presents only those commands specific to a particular environment, yet all are tightly integrated. For example, you can model individual parts in Solid Edge Part, then fit those parts together in the assembly environment, or start your designs directly in Solid Edge Assembly.




The sheet-metal capabilities in Solid Edge were instrumental in the creation of this subassembly of an industrial computer.

As you work, Solid Edge guides you through the process by displaying successive steps on the SmartStep ribbon bar and providing concise instructions on the status bar. When you're sketching, Solid Edge's IntelliSketch provides visual indicators, handles, and intent zones that help you create profiles quickly and accurately. The program's QuickPick tool highlights individual elements for easy selection.

Perhaps the most significant new feature in Version 7 is the XpresRoute module. This addition to the assembly environment enables you to quickly define the 3D path between parts and specify tube parameters. The software then constructs the tube as a separate part that you can subsequently modify.

Another significant addition is the automatic feature recognizer, which creates features and a supporting tree based on the topology and shape of a solid, rather than importing solids as a single body feature (as the program did in the previous release). This functionality is available when opening Parasolid files, and is also an option when importing IGES and STEP files.

Enhancements to the part modeler will please those who design plastic and cast parts. Improving on the Plastics+ feature from Version 6, the program's new thin-region capability enables users to construct thin-walled features within a selected region of a part, while a Thicken command allows the thickening of a local area or an existing solid. The Round command now includes a Soften Corner step on the SmartStep ribbon bar.

Sheet-metal design capability, long one of Solid Edge's strengths, has also been improved, with the addition of several new commands. A new Normal Cutout command constructs cutouts whose thickness faces are always perpendicular to the sheet faces, while the new Bead command constructs features used to stiffen a sheet-metal part. The creation of flanges has been enhanced so that you can create flanges that don't extend the full width of an edge. The program's Close Corner command now enables you to specify the type of bend treatment—such as a circular cutout—that you want to apply to the bent faces, and you can specify the corner relief for a chain of faces.

The Solid Edge drafting environment provides a few improvements of its own, including a new Attach Dimensions command, the ability to create split balloons (with quantities in the lower half) and add prefixes and suffixes to balloons, and support for international standards such as ISO and JIS.

While most additions in this release are les dramatic than the last time around, XpresRoute is a major enhancement. And the features targeted at the plastics industry as well as continued improvements to the product's already stellar sheet-metal capabilities make Solid Edge 7 one of the most intuitive and powerful feature-based modelers currently available.

### Solid Edge 7

**PRICE:** Solid Edge Classic, $4995; Boxed set (with tubing), $5995

**MINIMUM SYSTEM REQUIREMENTS:** Pentium processor; Windows 98/NT; 64MB of RAM; 150MB of disk space; 1024x768 256-color display (OpenGL accelerator with 65K colors recommended)

**Unigraphics Solutions**

Huntsville, AL
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*David Cohn is a consultant and technical writer based in Bellingham, Washington. He can be contacted at dcohn@az.com.*

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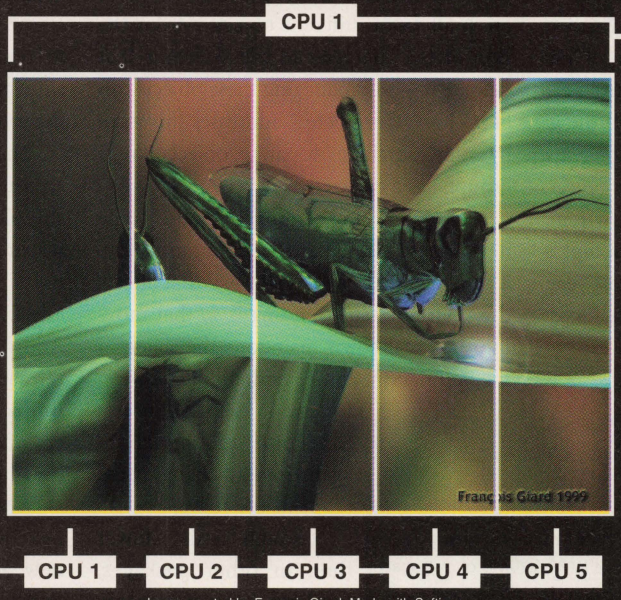


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# Maya Complete 2

## Advanced rendering and animation lead the list of improvements

BY GEORGE MAESTRI

Alias|Wavefront's Maya is the de facto standard for high-end 3D character and effects animation. Maya 2 adds to this heritage with several upgrades, particularly in rendering and animation, making it even more robust and efficient. Also new is a Relationship Editor, which lets you edit the way objects are grouped and linked.

Maya 2 is available in two versions. Maya Complete ($7495) includes modeling, rendering, animation, and dynamics tools, the Artisan and Maya FX modules, and MEL, an open interface for programming and scripting Maya. Maya Unlimited ($16,000) adds Maya Live, Maya Fur, Maya Cloth, and numerous advanced modeling features. Maya Complete, reviewed here, contains plenty of power for most modeling, animation, and effects applications.

In terms of modeling, Complete 2 sports enhanced NURBS capabilities. One of my favorites is the ability to move control vertices along the surface of an object in the U and V coordinates. This is handy for rearranging the underlying detail of an object. One of Maya's best modeling tools is Artisan, which enables you to deform and sculpt a surface using a virtual paintbrush. Last year, Artisan was a separate module that cost $5000, but now it's part of Complete 2.

A modeling limitation in Complete 2 is that the software's subdivision surfaces do not animate, which means you can't model polygonal surfaces in low resolution and then automatically smooth them to a higher resolution, something you can do in Maya Unlimited 2. Although this is certainly a drawback, you can get around it somewhat by using the software's new wrap deformer tool, which uses the shape of a second object to deform a first.

Additional enhancements to animation include several non-linear deformers that enable you to bend, flare, twist, and squash objects. Character animators will also like the smooth skinning function, with which vertices can now be influenced by more than one joint, which reduces the need for flexors and lattice deformers.

Complete 2 also includes a character set. In 3D animation software, most characters are built from different objects—from the skin of the character to the skeletons that deform it—and managing these objects can be a chore. Complete 2 addresses this issue by allowing these disparate objects to be grouped as a character.

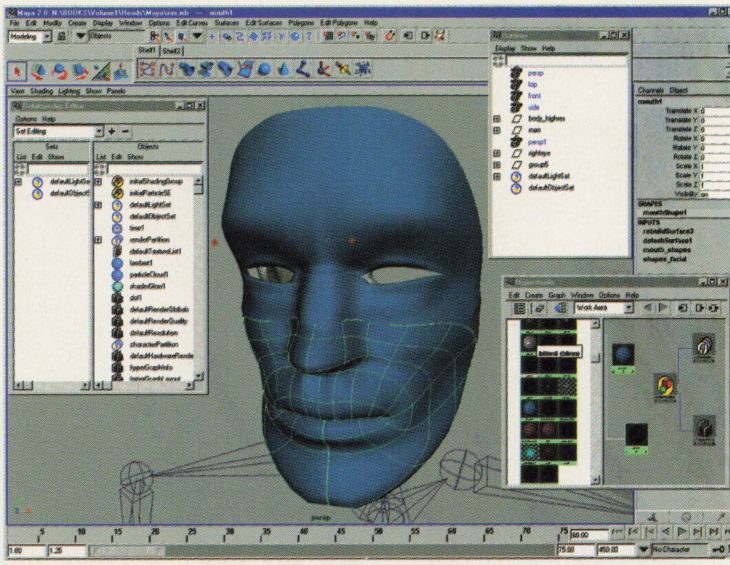
For keyframing, Complete 2 adds some new features aimed at character animators. These include a breakdown key that affects the keyframes surrounding it so that moving the breakdown maintains the shape of the animation curve, and an in-between function, which inserts time into an animation, again without changing the shape of the curve.

Though still slower than in other packages, rendering is noticeably faster in this version of Maya, and the renderer now takes advantage of multiple processors. The biggest enhancement is Maya's new IPR (Interactive Photorealistic Renderer), which allows you to render only those pixels that changed since the last render. This speeds up workflow tremendously.

The next version of Maya, 2.5, was announced several months ago and began shipping at press time. It will provide a feature called Paint Effects, which lets users paint and animate complex organic and painterly detail into 3D space. Additional features slated for the 2.5 release of Maya Complete include Maya Builder, which will enable game developers and programmers to create polygon-based content.

Altogether, Maya 2 boasts several great new features, particularly IPR and the new animation tools. The package still needs tweaking in terms of polygonal modeling and animation, but for the most part it's robust and powerful. Maya is an excellent all-around package, and is certainly at home in almost any production environment.

*George Maestri is a writer and animator living in Los Angeles.*



**With Maya Complete 2's Relationship Editor, you can edit the way objects are grouped and linked. This capability includes linking lights to objects, and editing shading groups, sets, deformers, partitions, and layers.**

### Maya Complete 2

**PRICE:** $7495

**MINIMUM SYSTEM REQUIREMENTS:**
Irix: Version 6.5, 24-bit graphics, 128MB of RAM, 220MB of disk space
Windows NT: NT 4.0 (service pack 5), 128MB of RAM, 220MB of disk space, three-button mouse, approved OpenGL card

**Alias|Wavefront**
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# Professional Workstation AP550

## Compaq debuts the Intel 840 chip

BY JOE GRECO

When computer users think of high-end graphics workstations, Hewlett-Packard, Intergraph, Sun, IBM, and SGI probably come to mind. But many will be surprised to learn that Compaq has been building workstations since 1996, and that the company's latest effort, the AP550, is its fifth-generation workstation and among the first of any on the market to incorporate the new Intel 840 chipset.

The AP550 can house either one or two Pentium III processors running at 600 or 733MHz, with 256K of L2 cache integrated. The new chips are optimized for better 3D graphics performance, and provide faster access to data in memory via the chip's built-in RAMBUS.

This machine has more than enough power to handle just about any chore. Users have a choice of either 128 or 256MB of memory, and the system will handle more than 2GB of memory when 512MB chips become available. Customers who are not ready to move to this new technology can configure their systems with a memory expansion card to run standard SDRAM.

Hard disk choices include 9 and 18GB Ultra3 SCSI drives, 10 and 20GB Ultra ATA/66 drives, and a 36.4GB option.

System designers at Compaq view the market for graphics controllers as divided into five segments, and they have provided an option for each. For 2D users, the company recommends the Matrox Millennium G400, while that company's Productiva G100 is installed for users needing multiple monitor support. Entry-level 3D modelers can go with the Elsa Synergy II or move up to the 3Dlabs Oxygen GVX1. For paramount performance, Compaq's own PowerStorm 600, built around the popular Wildcat 4000 adapter, is available as well.

My AP550, which lists for just under $5000 was handsomely configured with 256MB of RAM, one 733MHz processor, and a 9GB SCSI hard drive that was pre-partitioned in two 4GB segments. (According to technicians at Compaq, the gigabyte was lost because of the way Windows NT 4.0 handles partitioned hard drives.) The Windows NT service pack 4a was included, as was a 3Dlabs Oxygen GVX1 graphics card with its maximum 32MB of SGRAM, which is used for both frame buffering and texture mapping.

The Compaq AP550 converts easily from tower to desktop unit, as its drives can be quickly reoriented to suit a vertical or horizontal configuration.

### Slick Conversion

It took me only a few minutes to set up the Compaq AP550, as each connection was clearly marked. To make this tower a desktop unit, you don't just lay it on its side—you "convert" it by snapping out the front panel and pushing a latch that allows the three external drives to slide out. (Compaq should have provided slightly longer data cables, as these currently have to be unplugged.) Once the drives are out, you rotate them to the proper orientation and slide them back in—possible because the drive bay is a perfect six-inch square. The front bezel, which houses the Compaq logo and frames the drive bay, also pops out for reorientation.

While I had the machine open, I found it easy to access the four memory slots, four PCI slots, and one AGP Pro 4x slot. Inside are SCSI Ultra 3 and ATA/66 controllers and two internal drive bays. One aspect of the system I didn't like was the considerable noise made by its two fans, the one used to cool the 375-watt power supply, and the other to circulate air though the machine.

I tested various applications, including SolidWorks 98, Mechanical Desktop, 3D Studio Viz 3.0, and Rhino. All were in the neighborhood of 300 to 350% faster in both modeling and rendering when compared to a Windows NT machine with a 350MHz processor, 128MB of memory, and a basic graphics card.

Professional multimedia users may need to add the CD-R drive and perhaps a DVD player. They will also need to boost the video capabilities, as there is no composite or S-Video support built in.

These quibbles aside, the Compaq AP550 provides excellent value. With its numerous memory and storage options, convertible chassis, and powerful new processors, it provides plenty of power at a reasonable price.

**Professional Workstation AP550**

**PRICE AS REVIEWED:** $4973

**CONFIGURATION AS REVIEWED:** Single 733MHz processor, 256MB of memory, 9GB hard drive, 3Dlabs Oxygen GVX1 graphics card

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*Joe Greco is a writer and trainer specializing in CAD and 3D products.*

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**WIN** For maintaining levels of precision and topologies when solid models are moved between CAD systems, Trans 3D version 1.7 from Coretech International can convert even the largest complex models while preserving the semantic integrity of the data. This includes transferring the assembly structure with new options for automatic processing, improved handling of CAD files drawing layers, processing isolated entities, points, and construction lines; and conversion of object attributes such as names, graphic characteristics, and transparency/translucency/opacity. (Lyons, France; 011.33 4 72 52 30 90; www.coretech-int.com)
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**WIN** Among the most significant new capabilities in Anvil Express 3.0 from Manufacturing and Consulting Services Inc. is the Open 2D Mender, which is used for repairing two-dimensional CAD drawings. It heals gaps, overlaps, tangencies, redundancies, and more. The product can update and repair legacy drawings to make them mathematically accurate enough to move directly into 3D and solids. Other enhancements include the abilities to directly import AutoCAD DWG and DXF files up to and including release 14, use Visual Basic programming language to customize and run GRAPL/API programs, and drag and stretch surfaces with the mouse using the interactive surface and curve editors. Pricing starts at $1495 for the base Design Drafter and less than $14,000 for the complete CAD/CAM product line through 5-axis NC. (Scottsdale, AZ; 602-991-8700; www.mcsaz.com)
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**WIN** The interactive Viewpoint Digital Inc. e-Catalog offers access to the company's entire digital content archive of Premier 3D models, real-time models, texture maps, and 2D satellite imagery and motions as well as to software tools, including the Interchange 5.5 3D file translation sys-

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**CAD DRAWINGS**
**WIN** Featuring the products of almost 200 manufacturers, Edition 2.5 of Thomas Publishing Company's PartSpec and PlantSpec contain hundreds of thousands of CAD drawings, many generated parametrically, as well as product information for designers and engineers in several industries. PartSpec features 149 manufacturers, including 53 with new or updated data, while PlantSpec features 47 manufacturers, with 14 offering new or updated information. The titles are now AutoCAD 2000 compatible. A "Sequence of Selections" feature enables users to go back and selectively modify parameters they have previously entered for a part and generate a new drawing of a different part from the same product line. The CDs are available free to qualifying professionals (New York, NY; 212-290-7277)
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### MODELING & ANIMATION

**TRACKING PROJECTS**
**WIN** With Animo Production Tracker from Cambridge Animation, production studios can use the Internet, intranets, and internal networks to track every aspect of a production cycle. The software is fully integrated with Animo. Calculations from raw data, such as total number of scanned and painted frames done in Animo or other programs, are automatically stored in a standard database, which interacts with Animo Production Tracker. The product provides status reports of what was done on Animo tasks as well as data about work performed outside the computer, such as animation drawing, clean-up, and checking. A detailed record of what was done, by whom, and how long it took is collected and can be transferred to a standard spreadsheet program. (Cambridge, UK; 919-481-4599)
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**WEB MOTION**
**WIN** Unica from Motek Motion Technology is a Web-based product for deploying professionally captured movement in mainstream creative projects. Users can export the motion capture data into a range of professional 3D packages, including Softimage and 3D Studio Max. The product draws on a proprietary 1.5-terabyte catalog of motion-capture

data compiled over the last eight years. (Manchester, NH; 603-641-1300; www.motek.org)

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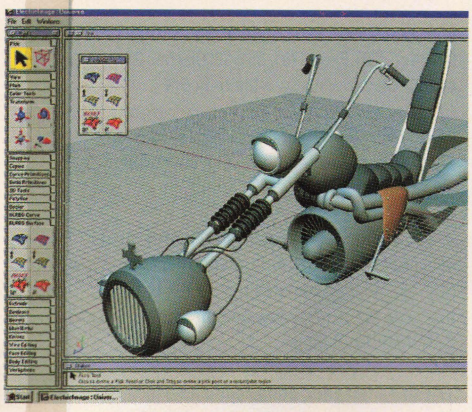
**A NEW UNIVERSE**

**WIN/MAC/UNIX** Electric Image: Universe from Play Inc. introduces



new capabilities to the Electric Image system, such as hybrid surface/solid modeling, real-time 3D video tracing and digital backlot technology as well as a sophisticated ray tracing engine, a deeper animation tool set, and the ability to directly save Trinity effects file formats. Additionally, Universe has an improved interface designed to take advantage of natural workflow processes with tear-off tool palettes, custom layouts, context-sensitive menu systems, and user-created tool palettes. (Rancho Cordova, CA; 916-851-0800; www.play.com)

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**PROCEDURAL SHADERS**

**WIN** A shader package from bhodiNUT for Cinema 4D SE and XL, Smells Like Almonds contains 42 procedural shader engines with more than 200 presets. Users can make attenuated reflections, translucent objects, weathered surfaces, brushed and tooled metals, and volumetric wood look realistic. Each shader offers up to 40 variable parameters. (Thousand Oaks, CA; 805-494-0718; www.bhodinut.com)

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## MULTIMEDIA/VIDEO

**NONLINEAR EDITING SYSTEM**

**WIN** Version 9.0 of Avid Technology's Media Composer offline/online nonlinear editing system includes dual streams of uncompressed ITU-R 601 video for online editing directly within the Media Composer environment at uncompressed video resolutions. Increased productivity and collaboration features include the ExpertRender mode, chromakey support, keyframable color effects, and soft-edge drop shadows on titles. The Universal Offline editing option enables 24P offline editing for creating frame-accurate cutlists and 24P HD EDLs, while working seamlessly with the Avid Symphony Universal Mastering systems capabilities via Total Conform. (Tewksbury, MA; 978-640-3541; www.avid.com)

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# HARDWARE

## SYSTEMS

**COOL ACCELERATION**

**WIN** Designed for CAD/CAM professionals and serious gamers alike, the Cold-Fusion desktop computing system from SYS Technology teams the Athlon (K7) processor from AMD with a built-in KryoTech cooling system to achieve an operating speed of 800MHz. Athlon boasts a 200MHz Alpha EV6 system bus, a 128K on-chip L1 cache, and a 512KB standard L2 cache, scalable to 8MB. In its standard configuration, the system comes with 128MB of RAM, a 9.1GB 7200rpm hard drive, Asus TNT 2, a 19-inch monitor, Creative Labs Live Value sound card, and a 56 V.90 WinModem with voice capabilities. (Cypress, CA; 714-821-3900; www.sys.com)

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## INPUT/OUTPUT

**EXPANDED PROJECTORS**

**WIN/MAC** A super-bright industrial-grade D-ILA projector, the G4000 from Hughes-JVC utilizes a 1600W Xenon arc lamp that features a specially designed compound reflector that results in 4000 ANSI lumens of brightness on screens up to 40 feet wide. With a contrast ratio greater than 350:1, video resolution of 1000 TV lines, and graphics resolution of


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1365x1024, the unit is intended for demanding large-venue applications. The price is $59,995. The company also offers the model G1500, which delivers high-brightness, high-quality pictures on a 35-foot-wide screen.This model is available with either a zoom lens or a special fixed-focal-length lens that features a vertically adjustable offset. The price is $18,995. (Carlsbad, CA; 760-929-5300; www.hjt.com)

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**PHOTO PRINTER**

**WIN/MAC** Geared for graphics professionals and high-end photo enthusiasts the BJC-8200 Color Bubble Jet photo printer from Canon Computer Systems produces 1200x1200 dot-per-inch prints at a cost of approximately $1.50 for each 8x10-inch photo print, including ink and photo paper. The printer's Advanced MicroFine Droplet Technology creates a four-picoliter droplet. The star-shaped printhead nozzle design enables the ink to be center-weighted and therefore ejected in a controlled straight line to appear as a perfectly round droplet on the page. The BJC-8200 Color Bubble Jet printer includes the Canon Creative Photo CD-ROM, which comes with Adobe Systems' PhotoDeluxe software. The price for the printer is $399. (Costa Mesa, CA; 800-652-2666; www.bjc-8200.com)

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## WEB AUTHORING TOOLS

**ONLINE DESIGN**

**WIN/MAC/LINUX** A free online application, GIFWorks 3.0 from Andover.Net enables Web builders to select, process, and create animations online using a standard Web browser. Twenty new visual effects such as chalk, emboss, oil paint, and water color, as well as a number of new editing tools are featured in this release. New GIFWorks editing tools include insert text, smart crop, replace color, add/remove transparency, and optimize to a "Web safe" palette. (Acton, MA; 978-635-5300; www.andover.net)

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# EVENTS

## DECEMBER

**12-13 · Game Developers RoadTrips Conference,** held in Boston. Contact: GDC RoadTrips (415-905-2388); (fax: 415-905-2222); www.gdconf.com/rtdm.

## JANUARY

**4-8 · MacWorld Expo,** held in San Francisco. Contact: IDG Expo (781-551-9800); (fax: 781-440-0300); www.macworldexpo.com

**24-26 · DaratechPlant 2000,** held in Houston, TX. Contact: Daratech Inc. (617-354-2339); www.daratech.com

**27-30 · Medicine Meets Virtual Reality,** held in Newport Beach, CA. Contact: Aligned Management Associates Inc. (860-444-0362); (fax: 860-447-9767); www.amainc.com /MMVR/MMVR.html

**31-Feb 2 · Imagina,** conference held in Monaco. Contact: Imagina (tel: +377-93-15-93-94); (fax: +377-93-15-93-95); www.ina.fr /Imagina/99/Evenements/concours.en.html

## FEBRUARY

**2-4 · Imagina,** exhibition held in Paris. Contact: Imagina (tel: +377-93-15-93-94); (fax: +377-93-15-93-95); www.ina.fr/Imagina/99/Evenements/concours.en.html

**3-5 · SMPTE Advanced Motion Imaging Conference,** held in San Francisco. Contact: SMPTE (914-761-1100); (fax: 914-761-3115); www.smpte.org

## MARCH

**7-9 · CAD/CAM/CAE Product Process Management Strategy Workshops 2000,** held in Boston. Contact: Daratech Inc. (617-354-2339); www.daratech.com

**10-12 · Game Developer's Conference,** held in San Jose, CA. Contact: GDC (415-905-2388); (fax: 415-905-2222); www.gdconf.com

**13-16 · National Manufacturing Week Conference and Exhibition,** held in Chicago. Contact: Reed Exhibition Companies; (+44 181 910 7878); fax (+44 181 910 7813); www.manufacturingweek.com

**19-22 · Simulation Solutions Conference,** held in Hilton Head Island, SC. Contact: Customer Service, Institute of Industrial Engineers (800-494-0460 or 770-449-0460); (fax: 770-441-3295); www.iienet.org /conted/simsol.htm

**28-30 · MICAD,** held in Paris. Contact: BIRP (tel: +33-1-53-17-11-40); (fax: +33-1-53-17-11-45); www.birp.com

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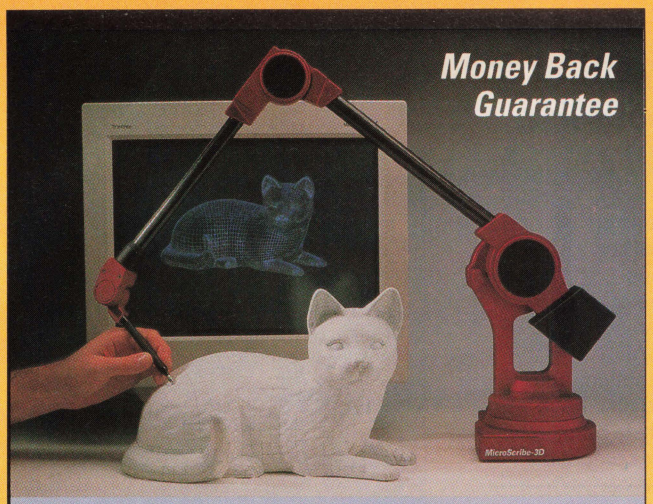


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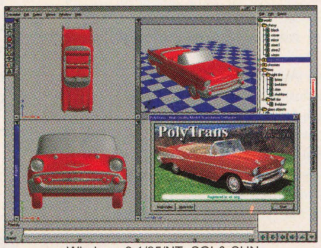


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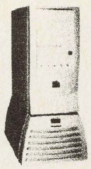

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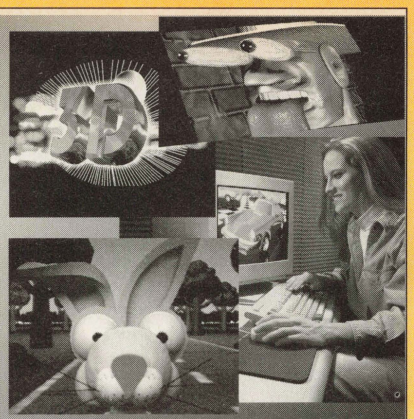

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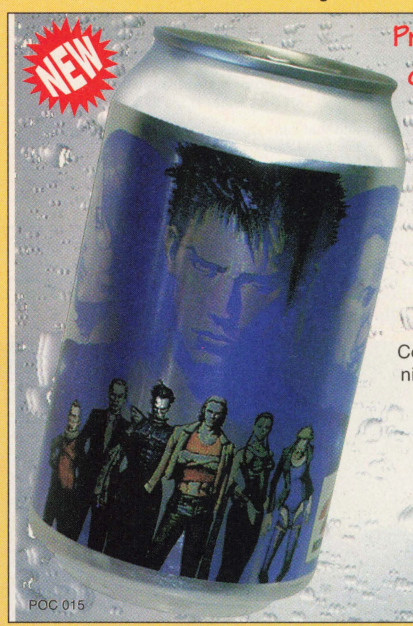


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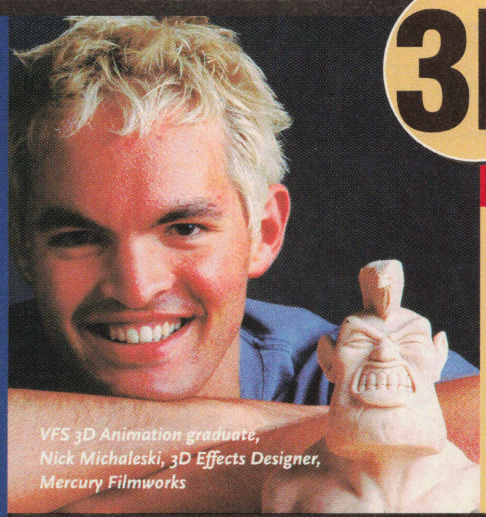

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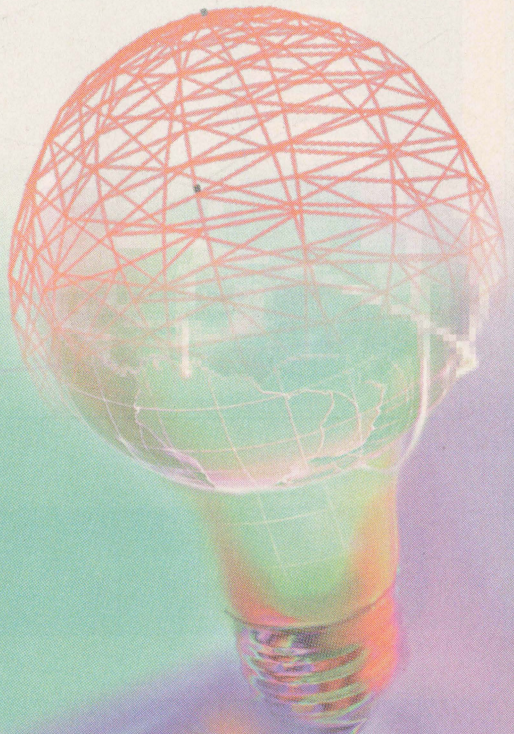

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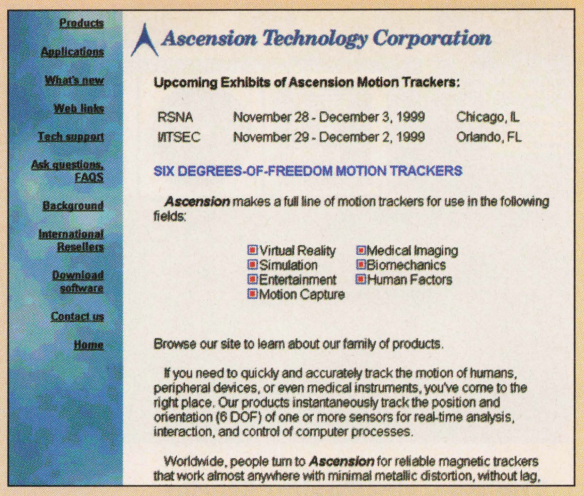


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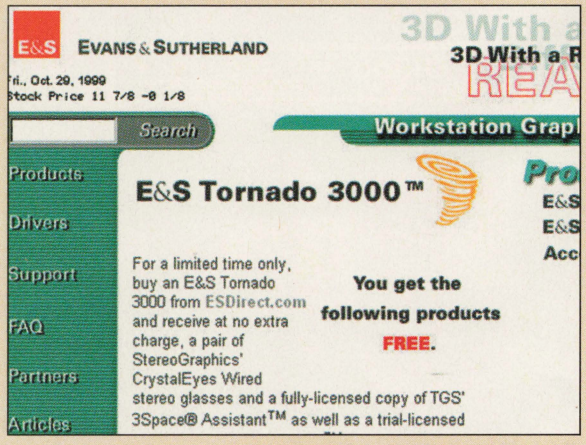


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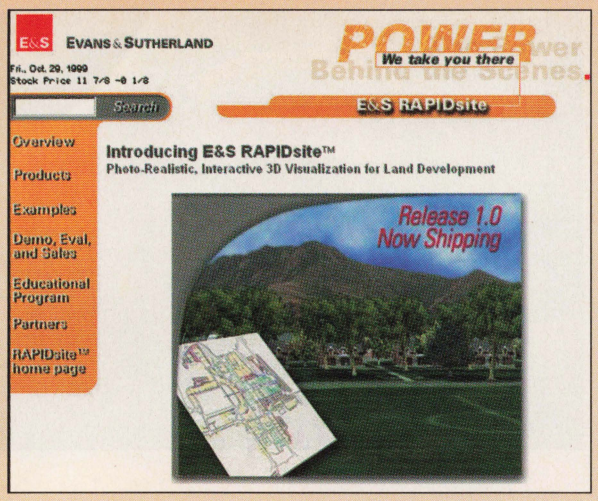


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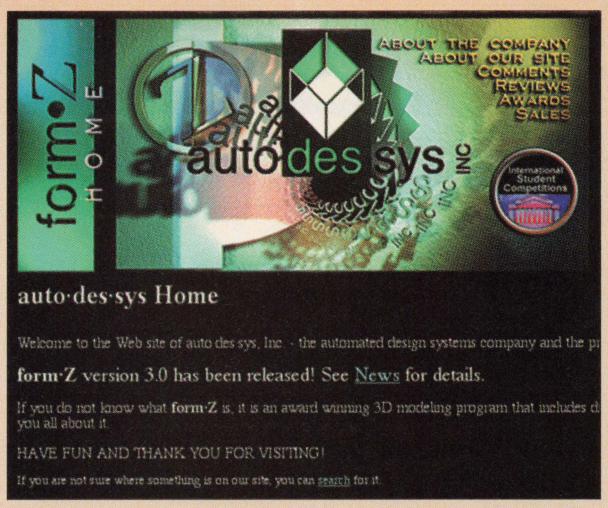


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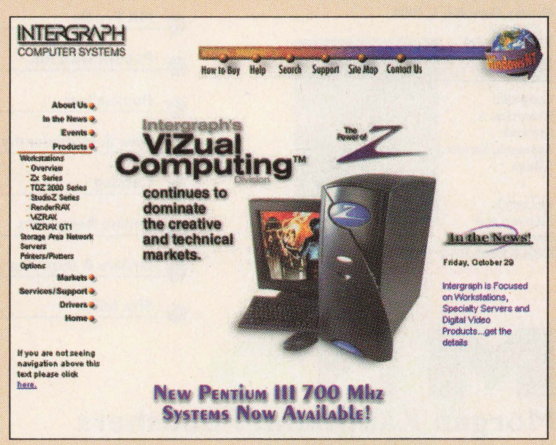


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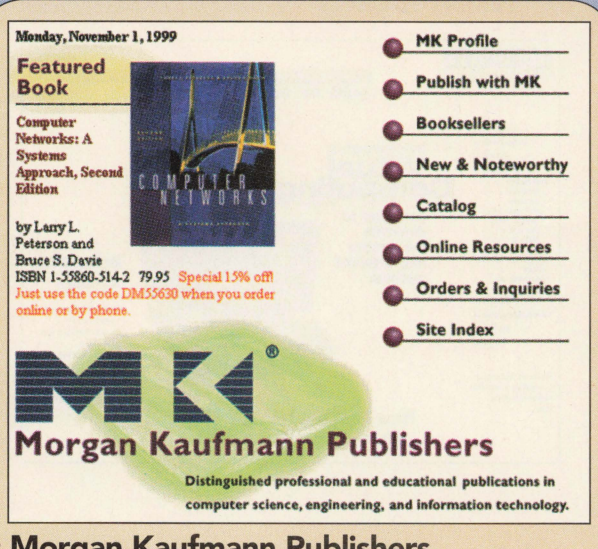


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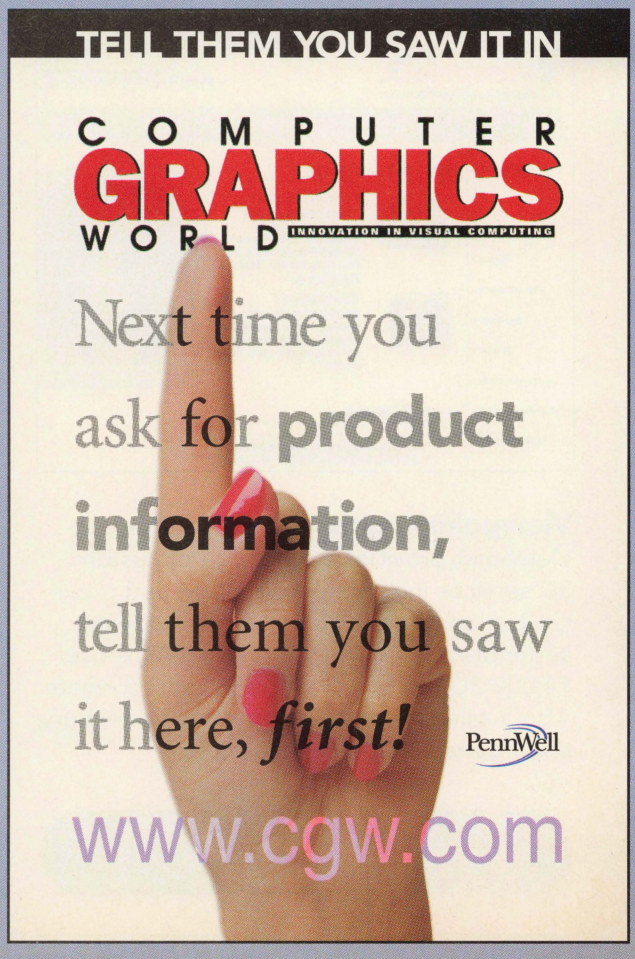

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# ZBrush

## A NEW DIMENSION IN PAINTING

When painting programs were first introduced to the consumer market, they presented a new paradigm: digital painting on a virtual (flat) canvas. Now, consumer computer processing speeds have skyrocketed, but the painting program paradigm hasn't changed.

That is, until now.

ZBrush expands the possibilities available to the computer artist by providing impressive 3D functions in a 2D painting environment. These functions are accessed through a familiar, intuitive palette-and-brush interface.

*ZBrush retains color, material, depth, and orientation information, allowing you to focus on experimenting and creating imaginative graphics.*

### PAINTING

Select a brush and begin painting. The first thing you'll notice in the ZBrush environment is that the paint has depth, like putty. ZBrush remembers the depth and surface attributes of the putty, so you can create an image, add or subtract material, add or change light sources, and brush on colors, material attributes and textures.

A real-time rendering engine updates these elements as you adjust them, so your images take shape as you create. Fun specialty tools enable you to add hair, tentacles, twists and spines with a single brushstroke, all completely adjustable by slider palettes.

### SCULPTING

You also have at your disposal a 3D primitives generator which creates spheres, cubes, cones and such. These primitives, or "object tools," can be brushed into your illustration as well, automatically oriented and correctly masked against the existing ZBrush canvas. For example, use the cone tool on a mass you've "painted" and it instantly normalizes itself to the surface, like an emerging spike or tooth. Invert the depth slider and it becomes a hole pointing toward the center of the mass. Move, resize, or rotate it, and it will orient itself to the surface accordingly.

But ZBrush's object tools aren't limited to these primitives. You can stretch, pinch, mold and colorize them in real time using powerful sculpting tools. You can even import 3D geometry objects and alter them in the same way — then export them again or save them as object tools for use in subsequent illustrations.

ZBrush is a painting tool unlike any other. By combining lights, color, depth and material properties with a powerful rendering engine, ZBrush allows you to create 2D and 3D-style images with ease.

ZBrush supports multiple undo levels in both the painting and the sculpting modes, encouraging you to experiment and better maximize your creativity.

### SEEING IS BELIEVING

A free, downloadable demo of ZBrush is available from Pixologic's website, www.pixologic.com. Try it out for yourself. Don't forget to visit the Tools Library for some ready-made object tools, and visit the Gallery for inspiration.

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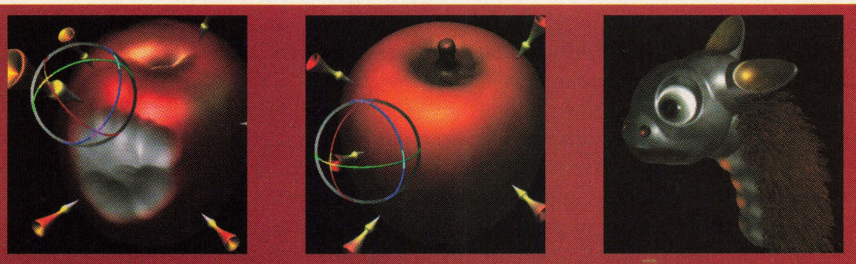

*Whether you create an object by painting it on the canvas (left), or by sculpting it from a 3D primitive (middle), added elements automatically align to the object's surface. Combine painted and sculpted objects with textures, colors, material attributes and specialty brushes to explore ideas quickly and effortlessly (right).*

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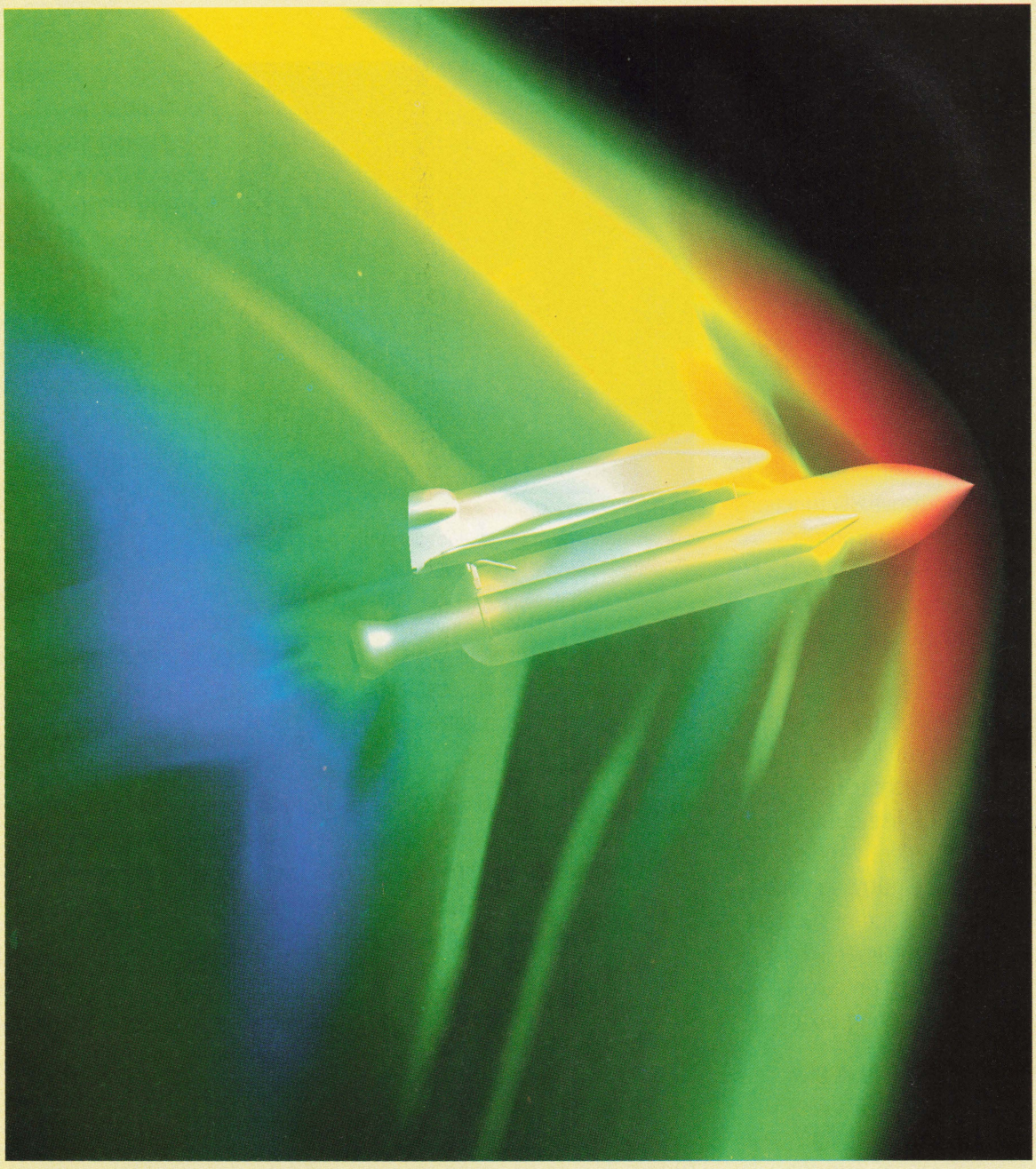
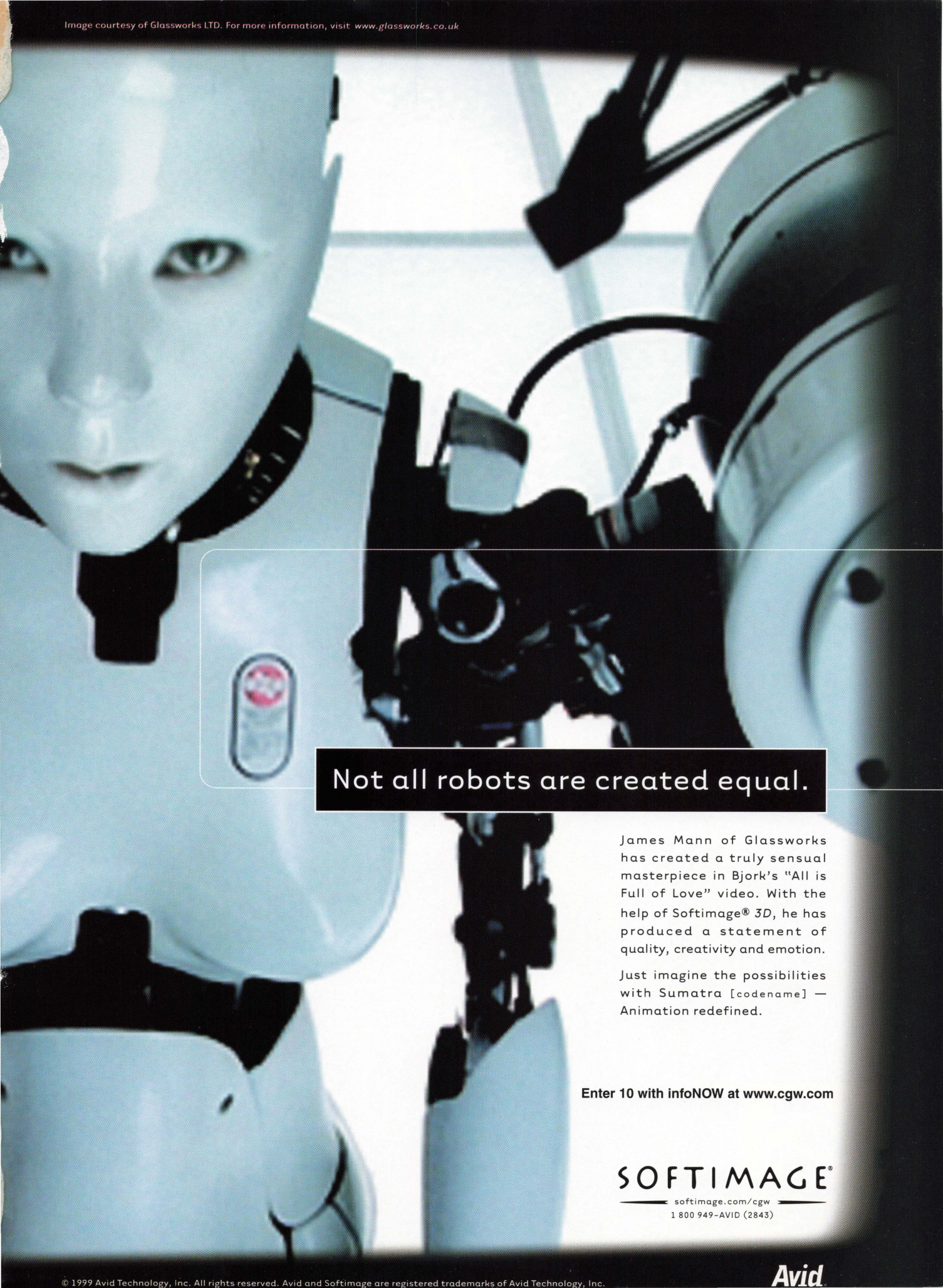


CFD simulation by Peter Buning et. al., NASA. Visualization by Jane Wilhelms and Allen Van Gelder, UCSC.

To better understand and communicate spacecraft aerodynamics, NASA scientists routinely rely on high-end visualizations of computational fluid dynamics simulations. In this image, the density of the air flow around a space shuttle launch vehicle is represented using direct volume rendering software developed by researchers at the University of California, Santa Cruz. The data being visualized consists of one million three-dimensional points organized as nine overlapping curvilinear grids. The software maps the data values in the volume to color and opacity. Density values below the free stream (the region where the airflow is unimpeded by the vehicle) are represented in blue, and those above the free stream range in color from green to red, depicting areas of increasingly dense airflow. Visualizations such as this offer NASA scientists comprehensive information about the flow patterns surrounding irregularly shaped objects, the complexity of which can be difficult if not impossible to understand without the help of visual tools. *—Diana Phillips Mahoney*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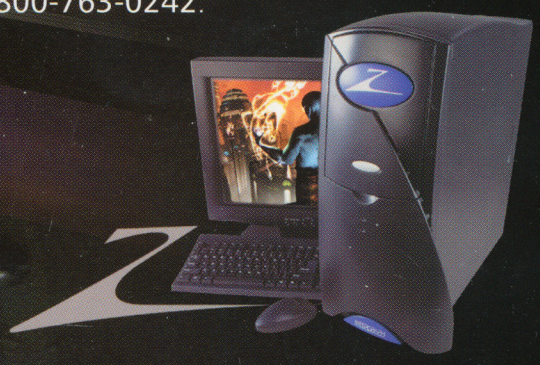

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